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Attorney Docket No. 381/41092
PATENT

#9

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Hiroshi ONISHI, *et al.*

Serial No.: 07/985,199 Group: TBD

Filed: December 3, 1992 Examiner: TBD

For: AUTOMATIC TRANSMISSION CONTROL SYSTEM FOR AN AUTOMOBILE

PETITION TO GRANT FILING DATE

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231
Attn: Office of Assistant Commissioner
for Patents

February 19, 1993

Sir:

Pursuant to 37 C.F.R. § 1.181, applicant in the above-captioned U.S. Patent Application hereby petitions the Commissioner, acting through the Office of the Assistant Commissioner for Patents, to grant a filing date of December 3, 1992, for the subject application. The petition fee of $130.00 as provided in 37 C.F.R. § 1.17(h) is enclosed herewith. In support of this petition, applicant submits the following statement of facts and argument.

Statement of Facts

1. The subject U.S. Patent Application was filed on December 3, 1992, by depositing the same with the Mail Room at the U.S. Patent and Trademark Office.

2. Attachment 1 hereto is a copy of the Application papers as filed on December 3, 1992. They include the following:

1.a. transmittal letter dated December 3, 1992;

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1.b. specification, together with 21 claims and 21 sheets of drawings;

1.c. Japanese Application No. 03-319205, filed in Japan on December 3, 1991; and

1.d. Preliminary Amendment dated December 3, 1992.

These documents were accompanied by a check for the required filing fee in the amount of $754.00.

3. A claim for foreign priority under 35 U.S.C. § 119 was asserted in the transmittal letter (Attachment 1.a) hereto, based on the Japanese Patent Application No. 03-319205 (Attachment 1.c hereto).

4. Because of a change of clerical personnel which occurred shortly prior to the filing in question, the present application was accompanied by a form of transmittal letter (Attachment 1.a. hereto) which differed from that ordinarily employed by counsel for such filings, which latter form identifies the inventors by name in a space specifically provided therefor. The omission of some of the inventors' names in the former was not detected by counsel at the time the transmittal papers were executed.

5. Attachment 2 is a certified translation of page 1 of Japanese Patent Application No. 03-319205 (Attachment 1.c), which was filed with, and as part of, the subject application. As this translation shows, page 1 of the Japanese priority application identifies the inventors as the following:

INVENTOR:
Name: Hiroshi ONISHI
Address or Residence: Hitachi Laboratories
Hitachi, Ltd.
4026 Kuji-cho
Hitachi City, Ibaraki Prefecture

INVENTOR:	
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Address or Residence:	Hitachi Laboratories Hitachi, Ltd. 4026 Kuji-cho Hitachi City, Ibaraki Prefecture
INVENTOR:	
Name:	Mitsuo KAYANO
Address or Residence:	Hitachi Laboratories Hitachi, Ltd. 4026 Kuji-cho Hitachi City, Ibaraki Prefecture
INVENTOR:	
Name:	Nobuo KURIHARA
Address or Residence:	Hitachi Laboratories Hitachi, Ltd. 4026 Kuji-cho Hitachi City, Ibaraki Prefecture

6. Subsequent to filing of the above papers, applicant received a Notice of Incomplete Application dated January 6, 1993, indicating that a filing date had not been granted because the inventors' names were missing from the papers as filed. A copy of the Notice of Incomplete Application is Attachment 3 hereto.

7. Applicant has responded to the Notice of Incomplete Application by the submission on February 4, 1993, of a Preliminary Amendment identifying the names of the inventors in English, in order to avoid any further delay in the granting of a filing date. However, for the reasons set forth hereinbelow applicant submits that a filing date of December 3, 1992, for this application is proper.

Argument

Based on the foregoing facts, applicant respectfully submits that this application was complete on the date it was originally filed with the U.S. Patent and Trademark Office, December 3, 1992. Although the English language papers did not identify all

the inventors, Attachment 2 hereto shows that the inventors were identified by name in the accompanying Japanese patent application, which was filed with the present application on December 3, 1992. As noted in the above statement of facts, the Japanese application was specifically referred to and identified in the transmittal letter which accompanied the present application, and a claim of priority was made based thereon. Although this application is not in the English language, 37 C.F.R. § 1.52(d) provides that an application may be filed in a language other than English. This being the case, it follows that the inclusion of the Japanese patent application identifying the names of the inventors, is sufficient to satisfy the requirement of 37 C.F.R. § 1.53(b) that the inventors' names be provided.

It would be appreciated if the undersigned were telephoned if there are any questions concerning this *Petition to Grant Filing Date* or the application in general.

Please credit any overpayments or charge any additional fees to the Deposit Account of Evenson, McKeown, Edwards & Lenahan, Account No. 05-1323.

Respectfully submitted,

EVENSON, McKEOWN, EDWARDS & LENAHAN

Gary R Edwards

Gary R. Edwards, Reg. No. 31,824
1200 G Street, N.W., Suite 700
Washington, D.C. 20005
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jdl

Attachment 3

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UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT		ATTY. DOCKET NO.
07/985,199	12/03/92	ONISHI	H	381/41092

EVENSON, WANDS, EDWARDS,
LENAHAN & MCKEOWN
1200 G ST, NW., STE 700
WASHINGTON, DC 20005

0000

DATE MAILED: 01/06/93

Notice of Incomplete Application

A filing date has NOT been assigned to the above identified application papers for the reason(s) shown below.

1. ☐ The specification (description and claims):
   a. ☐ is missing
   b. ☐ has pages______missing.
   c. ☐ does not include a written description of the invention.
   d. ☐ does not include at least one claim in compliance with 35 U.S.C. 112.

A complete specification in compliance with 35 U.S.C. 112 is required.

2. ☐ A drawing of Figure(s) ______ described in the specification is required in compliance with 35 U.S.C. 111.
3. ☐ A drawing of applicant's invention is required since it is necessary for the understanding of the subject matter of the invention in compliance with 35 U.S.C. 113.
4. ☑ The inventor's name(s) is missing. The full names of all inventors are required in compliance with 37 CFR 1.41.
5. ☐ Other:

All of the above-noted omissions, unless otherwise indicated, must be submitted within TWO MONTHS of the date of this notice or the application will be returned or otherwise disposed of. Any fee which has been submitted will be refunded less a $~~15.00~~ 130 handling fee. See 37 CFR 1.53(c).

The filing date will be the date of receipt of all the items required above, unless otherwise indicated. Any assertions that the items required above were submitted, or are not necessary for a filing date, must be by way of a petition directed to the attention of the Office of the Assistant Commissioner for Patents accompanied by the $~~140.00~~ 130 petition fee (37 CFR 1.17(h)). If the petition alleges that no defect exists, a request for refund of the petition fee may be included in the petition.

Direct the response to, and questions about, this notice to the undersigned, Attention: Application Branch.

A copy of this notice MUST be returned with response.

Enclosed:

☐ "General Information Concerning Patents". See page ______.
☐ Copy of a patent to assist applicant in making corrections.
☑ "Notice to File Missing Parts of Application", Form PTO-1532.
☐ Other: ____________

[signature] 56

For: Manager, Application Branch
(703) ~~557-3254~~ 308-1202

FORM PTO-1123 (REV. 7-87)

ATTORNEY'S/APPLICANTS COPY

61 [Mail room stamp] 22 1993

Attorney Docket No. 381/41092
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Hiroshi ONISHI, *et al*.

Serial No.: ~~Not yet assigned~~ 07/985,199

Filed: December 3, 1992

For: AUTOMATIC TRANSMISSION CONTROL SYSTEM FOR AN AUTOMOBILE

SUBMISSION OF MISSING PARTS IN APPLICATION

Honorable Commissioner of
Patent and Trademarks
Washington, D.C. 20231

February 22, 1993

Sir:

Attached hereto find:

1. The Notice to File Missing Parts of Application.
2. The executed Declaration.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any such fee or any deficiency in fees or credit any overpayment of fees to Deposit Account No. 05-1323.

It would be appreciated if the undersigned were telephoned if there are any questions concerning this *Submission of Missing Parts of Application* or the application in general.

Respectfully submitted,

EVENSON, McKEOWN, EDWARDS & LENAHAN

Gary R. Edwards

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Attachment 1.a

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December 3, 1992

BOX PATENT APPLICATION
Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

Re: Application of Hiroshi ONISHI et al.
"AUTOMATIC TRANSMISSION CONTROL SYSTEM
FOR AN AUTOMOBILE"
Our Ref: 381/41092

Dear Sir:

Attached hereto is the application identified above including the Specification, Twenty-one (21) Claims, Twenty (21) sheets of drawings of Figures 1-21(c), Japanese Priority Document and claim for priority, and Preliminary Amendment. The executed Declaration and Power of Attorney will be submitted at a later date.

The Government filing fee is calculated as follows:

Total claims	22	- 20 =	2	x $22 =	44.00
Independent Claims	3	- 3 =	0	x $74 =	0
Base Fee					$710.00
Multiple Dependent Claim Fee ($230.00)					
TOTAL FILING FEE					**$754.00**

A check for the statutory filing fee of **$754.00** is attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 05/1323. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. 1.16 and 1.17 which may be required during the entire pendency of the application to Deposit Account No. 05/1323 (381/41092). A duplicate copy of this transmittal letter is attached.

Priority is claimed from Japanese Patent Application No. 03-319205, filed in Japan on December 3, 1991. The certified copy of the priority document is enclosed.

Respectfully submitted,

EVENSON, WANDS, EDWARDS,
LENAHAN & McKEOWN

Donald D. Evenson

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21

AUTOMATIC TRANSMISSION CONTROL SYSTEM FOR AN AUTOMOBILE

BACKGROUND OF THE INVENTION

The present invention relates to transmission control systems for automobiles.

A prior-art transmission control system for an automobile is so constructed that a vehicle speed and a throttle valve opening are sensed as electric signals, and that a predetermined shift gear corresponding to the current values of the vehicle speed and the throttle valve opening is selected on the basis of a shift pattern which is preset, with the vehicle speed and the throttle valve opening as variables. Herein, a plurality of such shift patterns are set beforehand, and one of them is selected by the manipulation of the driver of the automobile.

In another transmission control system, the shift patterns are automatically selected and changed-over in accordance with the driving operation of the driver.

The control of a transmission in the prior art is such that a predetermined gear position corresponding to the current values of a vehicle speed and a throttle valve opening is selected on the basis of a shift pattern which is preset, with the vehicle speed and the throttle valve opening as variables.

In addition, the official gazette of Japanese Patent Application Publication No. 45976/1988 discloses a technique wherein a torque is evaluated from the pressure of an intake pipe, and a transmission gear ratio [(r. p. m. of an internal combustion engine)/(vehicle speed)] is determined from the torque.

These methods have made the performing an exact shift operation for the fluctuations of drive conditions difficult, especially for the change of a running load. For example, it is considered that the fuel consumption of the automobile will be enhanced without spoiling the drivability thereof, by upshifting earlier on a flat road or a gentle downward slope rather than on an upward slope. Such a shift operation, however, has heretofore been impossible because of the gear shift based on only the throttle valve opening and the vehicle speed.

Besides, as the vehicle is lightened, it becomes important to perform the shift control so as to correspond to the change of acceleration characteristics dependent upon the weight of the vehicle in the case of a starting acceleration. It is therefore considered possible to enhance the fuel consumption and to perform the exact shift operation corresponding to the drive conditions, in such a way that the running load and the vehicle weight are estimated, and that the shift pattern is changed in accordance with the vehicle weight and the running load in

an accelerating mode, while it also is changed in accordance with the running load in a decelerating mode.

Since the shift pattern is determined on the basis of the several typical drive conditions as stated above, the prior-art techniques have been sometimes incapable of the shift operation which reflects the drive conditions exactly. As a result, they have often worsened the fuel consumption.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an automatic transmission control system for an automobile in which the running load of the automobile is estimated so as to perform a shift operation which conforms to the running load.

In order to accomplish the object, an automatic transmission control system for an automobile in one aspect of performance of the present invention is constructed comprising load computation means for computing the automobile load; output torque estimation means for calculating an output torque with reference to the torque characteristics of the drive train of the automobile; running load estimation means for estimating a running load from the automobile load and the output torque; memory means for storing at least two shift schedules therein; and a shift schedule variable-control unit which determines a

shift schedule of an automatic transmission of the automobile during actual running of the automobile, on the basis of the estimated running load and the stored shift schedules.

Besides, in order to perform a shift operation which is based on, not only a running load, but also an estimated vehicle weight of an automobile, an automatic transmission control system for an automobile in another aspect of performance of the present invention may well be constructed comprising vehicle weight estimation means for estimating weight of the automobile; torque estimation means for estimating an output torque; acceleration input means for accepting an acceleration signal; running load estimation means for estimating the running load from the estimated vehicle weight, the estimated output torque and the input acceleration; memory means for storing a plurality of shift schedules therein; and gear position determination means for selecting one of the shift schedules on the basis of the vehicle weight and the estimated running load, and for determining a gear position of an automatic transmission of the automobile in accordance with the selected shift schedule.

In operation, the running load (and the vehicle weight) is (are) estimated, and the shift operation is performed in conformity with the vehicle weight and the running load. Therefore, the optimal shift pattern is formed in accordance

with a driving environment such as a mountain path, to enhance the drivability of the automobile. Moreover, on a flat road, the fuel consumption of the automobile is enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a shift control system which includes an automatic transmission control system in an embodiment of the present invention;

Fig. 2 is a schematic block diagram showing the hardware elements of the shift control system depicted in Fig. 1;

Fig. 3 is an explanatory diagram showing the details of input signals to and output signals from an AT (automatic transmission) control unit;

Fig. 4 is a block diagram of a vehicle weight estimation section which includes vehicle weight estimation means;

Fig. 5 is a diagram for explaining the time serialization of an acceleration response waveform;

Figs. 6A and 6B are diagrams for explaining a method of starting the time serialization;

Fig. 7 is a diagram for explaining the flow of processing for the generation of a time serialization start signal;

Fig. 8 is a flow chart showing the processing steps of means for generating the time serialization start signal;

Fig. 9 is a diagram for explaining the learning method of a neural network which is used in the vehicle weight estimation means depicted in Fig. 4;

Fig. 10 is a block diagram of a shift control section which includes torque converter-generated torque estimation means, engine-generated torque estimation means and load estimation means;

Figs. 11(a) and 11(b) are graphs showing an engine torque map and a torque converter characteristic map, respectively;

Fig. 12 is a flow chart showing a process for estimating an accessory torque;

Fig. 13 is a flow chart showing a process for estimating a torque generated by an engine;

Fig. 14 is a flow chart showing a process for estimating an output torque based on a torque converter;

Fig. 15 is a flow chart showing a process for estimating a running load torque from the estimated output torque;

Fig. 16 is a flow chart showing another method of the process for estimating the accessory torque;

Fig. 17 is a schematic block diagram for explaining gear position determination means;

Figs. 18(a) and 18(b) are explanatory diagrams

showing shift maps in a method of altering shift schedules which are based on load estimation and vehicle weight estimation;

Fig. 19 is a block diagram of an automatic transmission control system being another embodiment in which a shift schedule is continuously varied in consideration of a grade or slope;

Fig. 20 is an explanatory diagram showing a shift map in the embodiment illustrated in Fig. 19; and

Figs. 21(a), 21(b) and 21(c) are graphs for explaining how to decide an acceleration request.

PREFERRED EMBODIMENTS OF THE INVENTION

Now, embodiments of the present invention will be described with reference to the drawings. In the ensuing description, an expression "change gear ratio" or "gear ratio" shall mean the product between the gear ratio of a transmission and that of a final drive.

The schematic construction of an automatic transmission control system for an automobile in one embodiment of the present invention is illustrated in Fig. 1.

Throttle valve opening (TVO) sensing means 101 senses a throttle valve opening 121 in the automobile, which is delivered to vehicle weight estimation means 106, engine-generated torque estimation means 1001 and gear position

determination means 109.

Acceleration sensing means 102 senses the acceleration 122 of the automobile, which is delivered to the vehicle weight estimation means 106 and load estimation means 110.

Vehicle speed sensing means 103 senses the vehicle speed 123 of the automobile, which is delivered to the vehicle weight estimation means 106 and the gear position determination means 109.

Engine r. p. m. sensing means 104 senses engine r. p. m. ("revolutions per minute" also termed an "engine speed") 124 in the automobile, which is delivered to torque converter-generated torque estimation means 107 and the engine-generated torque estimation means 1001. The torque converter-generated torque estimation means 107 and the engine-generated torque estimation means 1001 are means for estimating torques generated by the torque converter of the automobile and the engine thereof, respectively.

Turbine r. p. m. sensing means 105 senses turbine r. p. m. (also termed a "turbine speed") 125 in the automobile, which is delivered to the torque converter-generated torque estimation means 107.

In the vehicle weight estimation means 106, the vehicle weight of the automobile is estimated on the basis of the throttle valve opening 121, acceleration 122 and vehicle speed 123. The estimated vehicle weight 126 is delivered to the gear position determination means 109 and the load

estimation means 110.

In the torque converter-generated torque estimation means 107, the torque generated by the torque converter is estimated from the engine speed 124 and the turbine speed 125. The estimated torque 1022 generated by the torque converter is delivered to the load estimation means 110.

In the engine-generated torque estimation means 1001, the torque generated by the engine is estimated from the throttle valve opening 121 and the engine speed 124. The estimated torque 1015 generated by the engine is delivered to the torque converter-generated torque estimation means 107.

In the load estimation means 110, a load torque is estimated from the estimated vehicle weight 126, the estimated torque 1022 generated by the torque converter, and the acceleration 122. The estimated load torque 1028 is delivered to the gear position determination means 109.

In the gear position determination means (which is also means for storing shift schedules therein) 109, a gear position is determined on the basis of the throttle valve opening 121, vehicle speed 123, vehicle weight 126 and load torque 1028. The determined gear position 129 is delivered to hydraulic drive means 111.

The hydraulic drive means 111 determines the driving hydraulic pressure of the clutch of the automatic transmission and drives the clutch so as to establish the

determined gear position 129.

Fig. 2 illustrates the arrangement of an engine and drive train and a control unit therefor for use in the embodiment of the present invention. An engine 201 and a transmission 202 supply the AT (automatic transmission) control unit 203 with signals 204 and 205 indicative of their respective operating states. In addition, vehicle signals 207 and ASCD (auto speed cruising device) control unit signals 208 are input to the AT control unit 203. In the AT control unit 203, a gear position is determined from the received signals so as to deliver shift instruction signals 206 to the transmission 202.

Fig. 3 illustrates the details of the signals shown in Fig. 2. Signals 304 thru 307 in Fig. 3 correspond to the engine output signals 204 in Fig. 2, while signals 308 thru 310 correspond to the transmission output signals 205. Besides, signals 311 thru 314 correspond to the vehicle signals 207, while signals 315 and 316 correspond to the ASCD control unit signals 208. On the other hand, signals 317 thru 321 correspond to the AT control unit signals 206. In Fig. 3, the input signals 304 ~ 316 are supplied to an AT control unit 301 through an input signal processing unit 302. Further, the output signals 317 ~ 321 from the AT control unit 301 are delivered through an output signal processing unit 303.

In the present invention, a vehicle weight estimating

method utilizes the fact that the corresponding accelerating operation of the acceleration and the vehicle speed, which arise when the driver of the automobile has depressed the accelerator pedal thereof, differs depending upon the vehicle weight. Thus, the vehicle weight is recognized from an accelerating response waveform. With this method, the cost of the control system is not increased by the use of a sensor for measuring the vehicle weight, and the vehicle weight can be estimated at a precision satisfactory for the shift control of the automatic transmission.

Fig. 4 is a detailed block diagram showing an example of the vehicle weight estimation means 106 depicted in Fig. 1. In Fig. 4, acceleration sensing means 401 delivers an acceleration 411 to time serialization means (acceleration input means) 405 and time serialization start signal generation means 404. Vehicle speed sensing means 402 delivers a vehicle speed 412 to the time serialization means 405. TVO sensing means 403 delivers a throttle valve opening 413 to the time serialization means 405 and the time serialization start signal generation means 404.

The time serialization start signal generation means 404 monitors both the signals of the acceleration 411 and the throttle valve opening 413, and it sends a signal 416 to the time serialization means 405 so as to start or initiate time serialization when the acceleration has risen owing to the driver's depression of the accelerator pedal, in other

words, in conformity with the accelerating response waveform.

Upon receiving the time serialization start signal 416, the time serialization means 405 time-serializes the acceleration 411, vehicle speed 412 and throttle valve opening 413 so as to deliver time-serial signals 414 to neural vehicle weight estimation means 406. The neural vehicle weight estimation means 406 estimates the vehicle weight on the basis of the received time-serial signals 414, and delivers an estimated vehicle weight 415.

Fig. 5 is a diagram for explaining the time serialization of the accelerating responses of the acceleration, vehicle speed and throttle valve opening. The time serialization is started at the point of time tso at which the acceleration has exceeded a predetermined threshold value αth. Then, the acceleration, vehicle speed and throttle valve opening are sampled at regular intervals of Δt.

The reason why the threshold value is set for the acceleration will be elucidated with reference to Figs. 6A and 6B. In a case where a threshold value is set for the throttle valve opening for the purpose of the time serialization in the accelerating mode and where the sampling is initiated in synchronism with the rise of the throttle valve opening, the rise of the longitudinal acceleration (the acceleration in the longitudinal direction

of the body of the automobile) becomes discrepant because of an individual difference involved in the way the driver depresses the accelerator pedal. In order to eliminate the discrepancy, the threshold value is set for the acceleration, and the sampling is started when the acceleration has exceeded the threshold value.

Fig. 7 illustrates the procedure of the processing of the time serialization start signal generation means 404 shown in Fig. 4. First, the closure of a throttle valve is confirmed. Subsequently, the opening of the throttle valve rises and exceeds the preset threshold value. Thereafter, the time serialization is initiated when the acceleration has exceeded the threshold value.

Fig. 8 illustrates the flow of that processing of the time serialization start signal generation means 404 which corresponds to Fig. 5. More specifically, whether or not the throttle valve is closed is checked at a step 801. When the throttle valve is closed, the processing flow proceeds to a step 802, and when not, it returns to the step 801. Further, when the throttle valve opening θ has exceeded its threshold value θ_{th} at the step 802, the processing flow proceeds to a step 803, and when not, it returns to the step 802. On condition that the acceleration α has exceeded its threshold value α_{th} at the step 803, the processing flow proceeds to a step 804. Otherwise, the processing flow returns to the step 803. At the step 804, the time

serialization start signal 416 indicated in Fig. 4 is delivered.

Fig. 9 is a diagram showing the learning method of a neural network which is used for the estimation of the vehicle weight. Referring to the figure, vehicle weight estimation means 901 is constructed of the Rumelhart type neural network which consists of the three layers of an input layer, an intermediate layer and an output layer. Each of the layers includes one or more neurons or arithmetic elements, and the neurons of the adjacent layers are coupled by synapses. Signals are transmitted along the input layer → the intermediate layer → the output layer. Each of the synapses is endowed with a weight, and the output signal of the corresponding neuron is multiplied by the weight of the synapse to form the input signal of the next neuron. Each neuron converts the sum of the input signals into the output signal by the use of a sigmoidal function.

The neural network 901 learns the vehicle weight in such a way that the weights of the respective synapses are so altered as to diminish the error between the true weight of the automobile and the vehicle weight estimated from the inputs of the acceleration, vehicle speed and throttle valve opening. In order to cope with various aspects of depressing the accelerator pedal, accelerating response waveforms are previously measured by experiments based on

the time serialization method shown in Fig. 4, while the vehicle weight and the throttle valve opening are being changed on an identical automobile. Subsequently, the time-serial waveforms of the acceleration, vehicle speed and throttle valve opening are input to the neural network 901, thereby obtaining the estimated vehicle weight 911. Next, the error 913 of the estimated vehicle weight 911 with respect to the true vehicle weight 912 is calculated.

Weight alteration means 902 alters the weights of the inter-layer synapses so as to diminish the error 913 between the estimated vehicle weight 911 and the true vehicle weight 912. As an algorithm for altering the weights, a back-propagation algorithm is typical, but another algorithm may well be employed.

A running load is estimated in order to perform the shift control in accordance therewith. Herein, the running load is evaluated by estimating an output torque and solving the equation of motion on the basis of the estimated output torque, the acceleration and the estimated vehicle weight.

Regarding the output torque estimation, there are a method in which the output torque is estimated from the slip and r. p. m. (also termed "revolution number" or "speed") of the torque converter in accordance with torque converter characteristics, and a method in which it is estimated from the r. p. m. of the engine and the opening of the throttle

valve in accordance with engine torque characteristics.

The estimation method based on the slip of the torque converter can estimate the output torque precisely when the slip of the torque converter is great, that is, when the ratio between the revolutions of the input and output of the torque converter is small. This method, however, exhibits an inferior precision in a region where the slip is small, that is, where the ratio between the input revolutions and the output revolutions is great.

On the other hand, the estimation method based on the engine torque characteristics exhibits a constant precision in the whole operating region of the engine, but it has the problem that torques required for operating accessories such as an air conditioner cannot be found.

In this embodiment, accordingly, in the region where the slip of the torque converter is great, the output torque is estimated on the basis of the torque converter, while at the same time, the torques necessary for operating the accessories such as the air conditioner are estimated. Besides, in the region where the slip of the torque converter is small, the output torque is calculated in such a way that the torques for the accessories estimated before are subtracted from the estimated torque based on the engine.

Fig. 10 is a diagram for explaining the method of estimating the output torque and the method of estimating

the load. In estimating the output torque from a torque generated by the engine, an engine output torque 1015 (Te) is derived from an engine torque map (engine-generated torque estimation means) 1001 on the basis of a throttle valve opening 1011 (TVO) and an engine revolution speed (or r. p. m.) 1012 (Ne). The total load torque 1016 (Tacc) of the accessories such as the air conditioner is subtracted from the engine output torque 1015, and the resulting difference is multiplied by the torque ratio 1017 (t) of the torque converter, thereby obtaining a turbine torque 1014 (Tt1) based on the engine revolution speed 1012.

On the other hand, in estimating the output torque from the pump revolution speed or r. p. m. (namely, the engine revolution speed) 1012 and turbine revolution speed or r. p. m. 1013 (Nt) of the torque converter, the ratio Nt/Ne between the turbine revolution speed 1013 and the engine revolution speed 1012 is calculated, and the torque ratio 1017 and pump torque capacity coefficient 1018 (τ) of the torque converter are derived from a torque converter-torque characteristic map 1002. The pump torque capacity coefficient 1018 of the torque converter is multiplied by the square of the engine revolution speed 1012, thereby obtaining a pump torque. Further, the pump torque is multiplied by the torque ratio 1017. Then, a turbine torque 1019 is obtained.

Accessory torque estimation means 1003 compares the

estimated turbine torque 1014 based on the engine and the estimated turbine torque 1019 based on the torque converter. Herein, when the ratio Nt/Ne between the turbine revolution speed and the engine revolution speed is smaller than 0.8, the estimated accessory torque 1016 is output so as to nullify the error between the turbine output torque 1014 based on the engine and the turbine output torque 1019 based on the torque converter. In contrast, when the ratio Nt/Ne between the turbine revolution speed and the engine revolution speed is not smaller than 0.8, the latest estimated accessory torque 1016 is output.

Here in this example, the output of the accessory torque estimation means 1003 is changed-over with a boundary at Nt/Ne = 0.8. However, the value 0.8 differs depending upon the characteristics of torque converters, and a value near the clutch point of the pertinent torque converter may be set. The reason therefor is that the Nt/Ne values corresponding to the large errors of the pump torque capacity coefficient of the torque converter are bounded by the clutch point.

Turbine torque estimation means 1004 delivers the turbine torque based on the torque converter, as an estimated turbine torque when the ratio Nt/Ne (1021) between the turbine revolution speed and engine revolution speed of the torque converter is smaller than 0.8, and it delivers the turbine torque based on the engine, as an estimated

turbine torque when not. The estimated turbine torque 1022 (Tt) thus produced is multiplied by a gear ratio 1024 (r), thereby obtaining an estimated output torque 1023 (To). An estimated running load torque 1028 (T_L) is calculated in such a way that the product 1025 ($M \times rw$) between the estimated vehicle weight 126 (refer also to Fig. 1) and the effective radius rw of a tyre or wheel is multiplied by a longitudinal acceleration 1026 (α), whereupon the resulting product 1027 is subtracted from the estimated output torque 1023.

Figs. 11(a) and 11(b) illustrate an engine torque map and a torque converter characteristic map, respectively. The engine torque map in Fig. 11(a) indicates the generated torque Te with the throttle valve opening set as a parameter, by taking the revolution speed Ne of the engine on the axis of abscissas. On the other hand, the torque converter characteristic map in Fig. 11(b) indicates the pump torque capacity coefficient τ and the ratio t of the input and output torques of the torque converter, by taking the ratio e of the input and output revolutions of the torque converter on the axis of abscissas.

Fig. 12 illustrates the flow of the processing of the accessory torque estimation means 1003 shown in Fig. 10. More specifically, the accessory torque is set at Tacc = 0 at a step 1201. If the slip e of the torque converter, namely, the aforementioned ratio Nt/Ne between the turbine

revolution speed 1013 and the engine revolution speed 1012 is smaller than 0.8, is checked at a step 1202. When the slip e is smaller than 0.8, the processing flow proceeds to a step 1203, and when not, it returns to the step 1202. At the step 1203, the difference Terr between the estimated turbine torque Tt1 based on the engine and the estimated turbine torque Tt2 based on the torque converter is evaluated as Terr = Tt1 - Tt2. At the next step 1204, the estimated accessory torque Tacc is calculated as Tacc = Tacc + Terr/t where t denotes the torque ratio of the torque converter.

Fig. 13 illustrates the flow of a process for obtaining the estimated turbine torque Tt1 based on the engine. At a step 1301, the values of the engine revolution speed Ne and the throttle valve opening TVO. At the next step 1302, the engine torque Te is derived from the engine torque map 1001 in Fig. 10 (refer also to Fig. 11(a)) on the basis of the engine revolution speed Ne and the throttle valve opening TVO. At the subsequent step 1303, the turbine torque Tt1 based on the engine is calculated in such a way that the accessory torque Tacc is subtracted from the engine torque Te, whereupon the resulting difference is multiplied by the torque ratio t of the torque converter.

Fig. 14 illustrates the flow of a process for obtaining the estimated turbine torque Tt2 based on the revolutions of the torque converter. At a step 1401, the values of the

vehicle speed Vsp, engine revolution speed Ne and gear ratio r are read. Subsequently, the turbine revolution speed Nt is computed from the vehicle speed Vsp and the effective radius rw of the wheel at a step 1403. At the next step 1405, the slip e of the torque converter is calculated, and the pump torque capacity coefficient τ and the torque ratio t of the torque converter are derived from the torque converter characteristic map 1002 in Fig. 10 (refer also to Fig. 11(b)). At the subsequent step 1406, the turbine torque Tt2 (1019 in Fig. 10) based on the torque converter is calculated in such a way that the square of the engine revolution speed Ne is multiplied by the pump torque capacity coefficient τ, thereby obtaining the pump torque Tp, whereupon the pump torque Tp is multiplied by the torque ratio t of the torque converter.

Incidentally, in this process, the turbine revolution number Nt may well be directly obtained instead of being computed from the vehicle speed Vsp. In such a case, the steps 1401 and 1403 are respectively replaced with steps 1402 and 1404. More specifically, the value of the engine revolution speed Ne is read at the step 1402, and the value of the turbine revolution speed Nt is read at the step 1404.

Fig. 15 illustrates the flow of a process for obtaining the estimated load torque TL from the estimated output torque To and the acceleration α. If the revolution ratio e of the torque converter is smaller than 0.8, is checked at a

step 1501. When the ratio *e* is smaller, the flow proceeds to a step 1502, and when not, it proceeds to a step 1503. At the step 1502, the estimated turbine torque Tt is set at the turbine torque Tt2 based on the torque converter, whereupon the flow proceeds to a step 1504. On the other hand, at the step 1503, the estimated turbine torque Tt is set at the turbine torque Tt1 based on the engine, whereupon the flow proceeds to the step 1504. Subsequently, at the step 1504, the estimated turbine torque Tt is multiplied by the gear ratio *r*, thereby obtaining the estimated output torque To. At the next step 1505, the estimated load torque TL is calculated in such a way that the product among the estimated vehicle weight M, the effective radius rw of the wheel and the acceleration α is subtracted from the estimated load torque TL.

Fig. 16 illustrates another method of evaluating torques required for the accessories. This method consists in that the torques of the accessories are set for the individual devices beforehand, and that, when the pertinent device is "ON", the corresponding value is added. In the figure, the torque of an air conditioner is taken as an example.

At a step 1601, Tacc = 0 is set. If the air conditioner is "ON", is checked at a step 1602. When the air conditioner is "ON", the flow of the method proceeds to a step 1603, and when not, the processing of the method is

ended. At the step 1603, the accessory torque Tacc is set at Tacc = Tacc + Tac where Tac denotes the torque of the air conditioner.

There will now be explained a control in which a shift pattern is changed on the basis of an estimated load and an estimated vehicle weight. Fig. 17 is a block diagram of gear position determination means for determining a gear position from the estimated vehicle weight and the estimated load.

An upshifting speed change line selector 1701 receives a vehicle weight signal 1711 and a load signal 1712 as inputs, and it delivers an upshifting speed change line 1714 to gear position final-determination means 1703 as an output. A downshifting speed change line selector 1702 receives the load signal 1712 as an input, and it delivers a downshifting speed change line 1715 as an output. The gear position final-determination means 1703 receives a vehicle speed signal 1716 and a throttle valve opening signal 1717 in addition to the upshifting speed change line 1714 and the downshifting speed change line 1715, and it delivers a gear shift signal 1713.

Figs. 18(a) and 18(b) illustrate the controls based on the vehicle weight and the load, for upshift and for downshift, respectively. A shift map as shown in Fig. 18(a) is used for the upshift, while a shift map as shown in Fig. 18(b) is used for the downshift.

In the case of the upshift, the speed change line moves along lines ①, ② and ③ as the vehicle weight and the load enlarge. On the other hand, in the case of the downshift, the speed change line moves along lines Ⓐ, Ⓑ and Ⓒ as the load enlarges.

In the case of the downshift, when the throttle valve opening (θ + h) is small, the speed change line Ⓐ moves toward the higher vehicle speed Vsp. This is intended to apply engine braking.

Although the speed change line is determined from the vehicle weight and the running load in the above embodiment, it may well be determined from only the running load.

In addition, although any of the preset speed change lines is selected in the above embodiment, the speed change line may well be continuously varied on the basis of the estimated load, the vehicle weight and a grade or slope. A method for the continuous variation may be such that two speed change lines which do not intersect each other are set, and that they are divided internally or externally in the direction of, for example, the vehicle speed. This method will be explained in detail below.

Fig. 19 is a block diagram showing another embodiment of the automatic transmission control system for an automobile in which the speed change line is determined from the gradient (an inclination angle) and the vehicle weight.

This system comprises a gradient resistance (hill-

climbing resistance) calculation unit (load estimation means) 1901, a continuously variable quantity calculation unit 1902, a continuous variation unit 1903, a shift pattern-A memory 1904 and a shift pattern-B memory 1905. The continuously variable quantity calculation unit 1902 and the continuous variation unit 1903 constitute a shift schedule variable-control unit. The shift pattern-A memory 1904 and the shift pattern-B memory 1905 constitute means for storing shift schedules therein.

The gradient resistance calculation unit (load estimation means) 1901 is supplied with the gradient θ and the vehicle weight W, and it calculates a gradient increment resistance ΔL in accordance with the following equation (1):

$$\Delta L = W \cdot g \cdot \sin \theta \qquad \text{-----(1)}$$

where g denotes the gravitational acceleration.

The continuously variable quantity calculation unit 1902 calculates a continuously variable quantity Z in accordance with the following equations (2) and (3):

$$y = \frac{\Delta L}{Wst \cdot g} \qquad \text{-----(2)}$$

$$(\because\ y \simeq \frac{W}{Wst} \cdot \theta)$$

$$Z = \varepsilon \cdot y \qquad \text{-----(3)}$$

where y denotes a gradient equivalent coefficient, which may well be calculated by the aforementioned equation $y \simeq \frac{W}{Wst} \cdot \theta$. Besides, Wst represents a standard vehicle weight previously set as a default, and ε represents a continuously variable quantity-conversion coefficient.

The continuous variation unit 1903 determines a gear position in such a way that a value X indicated by Equation (4) below is calculated from the continuously variable quantity Z, whereupon the speed change line is variably obtained on the basis of the value X and the throttle valve opening as illustrated in Fig. 20. Shift patterns A and B indicated in Fig. 20 are respectively sent from the shift pattern-A memory 1904 and the shift pattern-B memory 1905. Thus, a smooth shift operation conforming to the gradient is realized.

$$X = X1 + (X2 - X1) \cdot Z \qquad \text{-----(4)}$$

There will now be explained a case where a gear position is determined from the vehicle weight, the gradient and an acceleration request. In this case, the gradient increment resistance in Fig. 19 is evaluated as stated below. Processing after the evaluation of the gradient increment resistance is the same as in Fig. 19. First, the temporal variation of the throttle valve opening as shown in Fig. 21(a) is measured. Subsequently, the time derivative of the throttle valve opening is obtained as shown in Fig. 21(b). The acceleration request α is calculated in accordance with the preset functional relationship of the following equation (5), on the basis of the throttle valve opening (TVO) and the time derivative thereof:

$$\alpha = f(\Delta TVO/\Delta T,\ TVO,\ t) \qquad \text{-----(5)}$$

An example of the obtained result of the acceleration

request α is shown in Fig. 21(c). In this manner, the presence of the acceleration request α is decided when the throttle valve opening and the differentiated value thereof have predetermined values or above.

The gradient increment resistance ΔL is calculated by the following equation (6) on the basis of the vehicle weight W, the gradient θ and the decided acceleration request α:

$$\Delta L = W \cdot g \cdot \sin\theta + W \cdot \alpha \qquad \text{-----(6)}$$

With this embodiment, a smooth shift operation with the acceleration request also taken into consideration can be realized.

As described above, according to the present invention, the vehicle weight is estimated from the drive characteristics of the automobile, the output torque is estimated from the slip of the torque converter or from the revolution speed of the engine and the opening of the throttle valve, and the running load is estimated from the output torque and the acceleration. Then, in the upshift operation, the speed change line is moved by utilizing both the vehicle weight and the running load, while in the downshift operation, it is moved in consideration of only the running load. Thus, the fuel consumption is enhanced, and the exact shift operation conformed to the drive conditions is realized.

Incidentally, although the foregoing embodiments have

been described as estimating the vehicle weight, the present invention is not restricted thereto. The vehicle weight may well be directly measured by a sensor.

According to the present invention, a running load is estimated, and a shift operation conformed to a vehicle weight and the running load is performed. It is therefore possible to provide an automatic transmission control system for an automobile in which the optimal shift pattern is formed in conformity with a driving environment (such as driving on a mountain path, or driving with many passengers on board), thereby enhancing the drivability of the automobile, and in which the fuel consumption of the automobile is enhanced more than in the prior art when driving on a flat road.

WHAT IS CLAIMED IS:

1. An automatic transmission control system for an automobile, comprising:

load computation means for computing a load of said automobile;

output torque estimation means for calculating an output torque with reference to torque characteristics of a drive train of said automobile;

running load estimation means for estimating a running load from the automobile load and said output torque;

memory means for storing at least two shift schedules therein; and

a shift schedule variable-control unit which determines a shift schedule of an automatic transmission of said drive train during actual running of said automobile, on the basis of the estimated running load and the stored shift schedules.

2. An automatic transmission control system for an automobile as defined in Claim 1, wherein said output torque estimation means calculates said output torque with reference to, at least, the torque characteristics of a torque converter of said automatic transmission.

3. An automatic transmission control system for an

automobile as defined in Claim 1, wherein said output torque estimation means calculates said output torque by calculating an output torque of a torque converter of said automatic transmission with reference to, at least, the torque characteristics of said torque converter, and further multiplying the calculated output torque of said torque converter by a gear ratio of a gear stage of said automatic transmission corresponding to a shift instruction.

4. An automatic transmission control system for an automobile as defined in Claim 1, wherein said output torque estimation means calculates said output torque with reference to, at least, the torque characteristics of a torque converter of said automatic transmission and those of an engine of said drive train.

5. An automatic transmission control system for an automobile as defined in Claim 1, wherein said output torque estimation means calculates said output torque by changing-over the torque characteristics of an engine of said drive train and those of a torque converter of said automatic transmission when a ratio between an input revolution speed and an output revolution speed of said torque converter has exceeded a predetermined value.

6. An automatic transmission control system for an

automobile as defined in Claim 1, further comprising: a neural network which has been supplied with values of, at least, a throttle valve opening and an acceleration so as to learn values of a vehicle weight corresponding to the supplied values beforehand;

said load computation means being vehicle weight estimation means for estimating said vehicle weight of said automobile;

said vehicle weight estimation means estimating said vehicle weight by time-serializing each of, at least, said throttle valve opening and said acceleration and then supplying resultant time-serial signals to said neural network.

7. An automatic transmission control system for an automobile as defined in Claim 6, wherein said vehicle weight estimation means supplies said time-serial signals of said throttle valve opening and said acceleration at a timing at which said throttle valve opening has exceeded a predetermined value and at which said acceleration has also exceeded a predetermined value.

8. An automatic transmission control system for an automobile as defined in Claim 1, wherein said shift schedule variable-control unit varies a speed change line of said automatic transmission continuously in dependency on

said running load.

9. An automatic transmission control system for an automobile as defined in Claim 1, wherein said shift schedule variable-control unit varies a speed change line of said automatic transmission continuously in dependency on, at least, a vehicle weight of said automobile.

10. An automatic transmission control system for an automobile as defined in Claim 1, wherein said shift schedule variable-control unit varies a speed change line of said automatic transmission continuously in dependency on an inclination angle of the running automobile and a vehicle weight of said automobile.

11. An automatic transmission control system for an automobile as defined in Claim 1, wherein said shift schedule variable-control unit varies a speed change line of said automatic transmission continuously in dependency on an inclination angle of the running automobile, a vehicle weight of said automobile, and a request for an accelerating operation made by a driver of said automobile.

12. An automatic transmission control system for an automobile as defined in Claim 1, wherein:

said load computation means is vehicle weight

estimation means for estimating a vehicle weight of said automobile;

said vehicle weight estimation means includes acceleration input means for accepting an acceleration signal;

said running load estimation means estimates said running load from the estimated vehicle weight, the calculated output torque and the accepted acceleration; and

said shift schedule variable-control unit is gear position determination means for selecting one of said shift schedules in accordance with said estimated vehicle weight and the estimated running load, and for determining a gear position of said automatic transmission in conformity with the selected shift schedule.

13. An automatic transmission control system for an automobile as defined in Claim 12, wherein:

said vehicle weight estimation means estimates said vehicle weight of said automobile by accepting a throttle valve opening signal and a vehicle speed signal in addition to said acceleration signal;

said torque estimation means estimates said output torque by accepting a revolution speed signal of an engine of said drive train and a turbine revolution speed signal of a torque converter of said automatic transmission; and

said running load estimation means estimates said

running load from said acceleration signal, said estimated vehicle weight and the estimated output torque.

14. An automatic transmission control system for an automobile as defined in Claim 12, wherein said torque estimation means has a mode in which said output torque is estimated from a turbine revolution speed of a torque converter of said automatic transmission and a revolution speed of an engine of said drive train, and a mode in which said output torque is estimated from a throttle valve opening of said engine and said revolution speed of said engine, said modes being established in dependency on a revolution ratio of a torque converter of said automatic transmission.

15. An automatic transmission control system for an automobile as defined in Claim 12, wherein said running load estimation means estimates said running load by solving an equation of motion on the basis of said vehicle weight, said output torque and said acceleration of said automobile.

16. An automatic transmission control system for an automobile, comprising:

vehicle weight measurement means for measuring a vehicle weight of said automobile;

torque estimation means for estimating an output

torque;

acceleration input means for accepting an acceleration;

running load estimation means for estimating a running load from the measured vehicle weight, the estimated output torque and the input acceleration;

memory means for storing at least two shift schedules therein; and

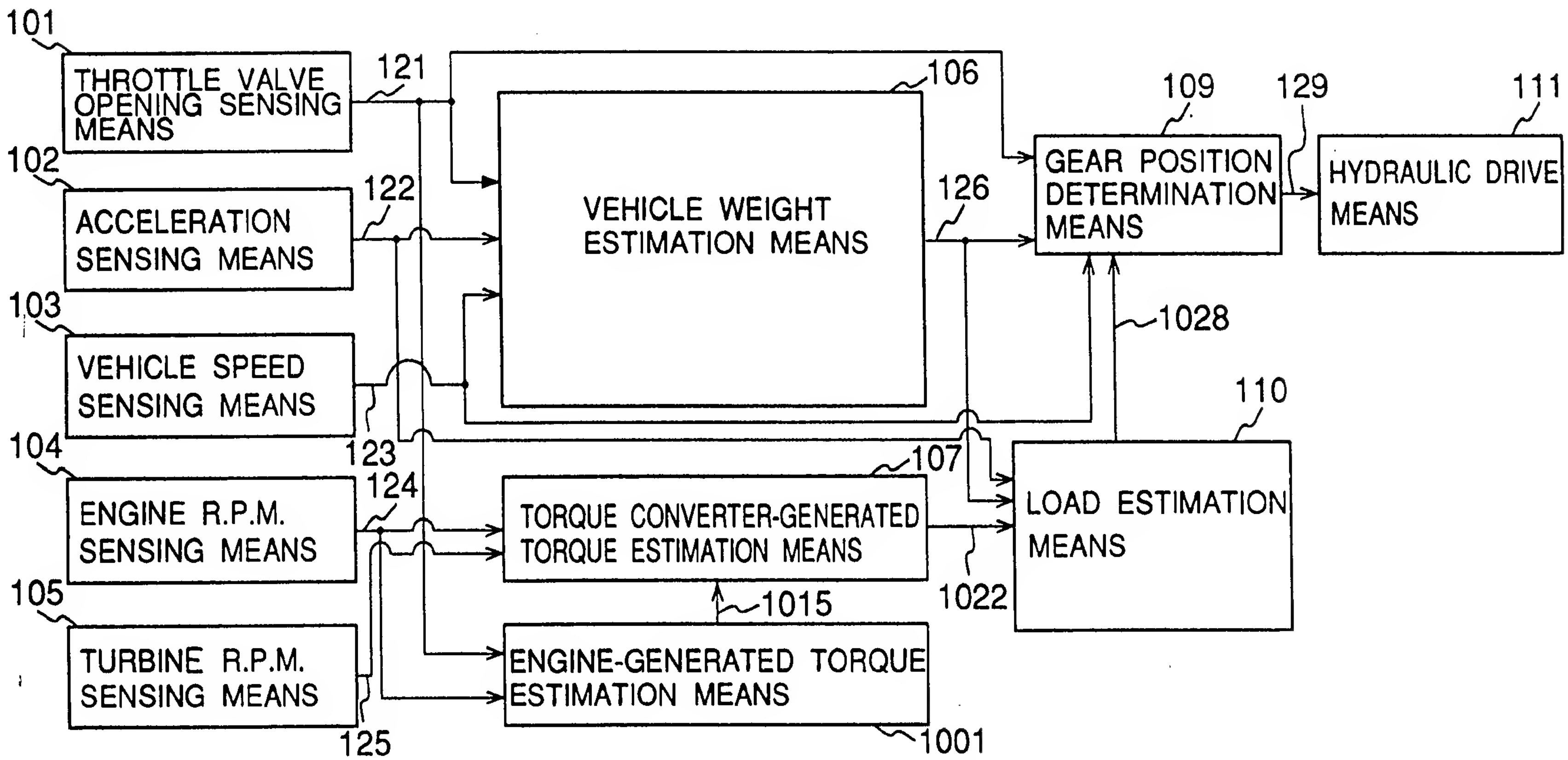
gear position determination means for determining a shift schedule of an automatic transmission of said drive train during actual running of said automobile, on the basis of said vehicle weight, the estimated running load and the stored shift schedules, and for determining a gear position of said automatic transmission in accordance with the determined shift schedule.

21. An automatic transmission control system for an automobile as defined in Claim 12, further comprising start signal generation means for delivering an acceptance start signal in synchronism with rise of said acceleration signal when said acceleration signal is to be accepted.

ABSTRACT

An automatic transmission control system for an automobile, comprising a vehicle weight estimation unit (106 in Fig. 1) which estimates a vehicle weight of the automobile; a torque estimation unit (107, 1001) which estimates an output torque, an acceleration input unit (102) which accepts an acceleration signal; a load estimation unit (110) which estimates a running load from the estimated vehicle weight, the estimated output torque and the accepted acceleration; a memory which stores a plurality of shift schedules therein; and a gear position determination unit (109) which includes the memory, and which selects one of the shift schedules in accordance with the vehicle weight and the estimated running load, so as to determine a gear position of an automatic transmission of the automobile in conformity with the selected shift schedule. An exact shift operation conformed to the vehicle weight and the running load can be performed, and an enhanced fuel consumption can be attained.

FIG.1



101
THROTTLE VALVE OPENING SENSING MEANS
102
ACCELERATION SENSING MEANS
103
VEHICLE SPEED SENSING MEANS
104
ENGINE R.P.M. SENSING MEANS
105
TURBINE R.P.M. SENSING MEANS
121
122
123
124
125
106
VEHICLE WEIGHT ESTIMATION MEANS
107
TORQUE CONVERTER-GENERATED TORQUE ESTIMATION MEANS
1015
1001
ENGINE-GENERATED TORQUE ESTIMATION MEANS
126
1022
109
GEAR POSITION DETERMINATION MEANS
1028
110
LOAD ESTIMATION MEANS
129
111
HYDRAULIC DRIVE MEANS

FIG.2

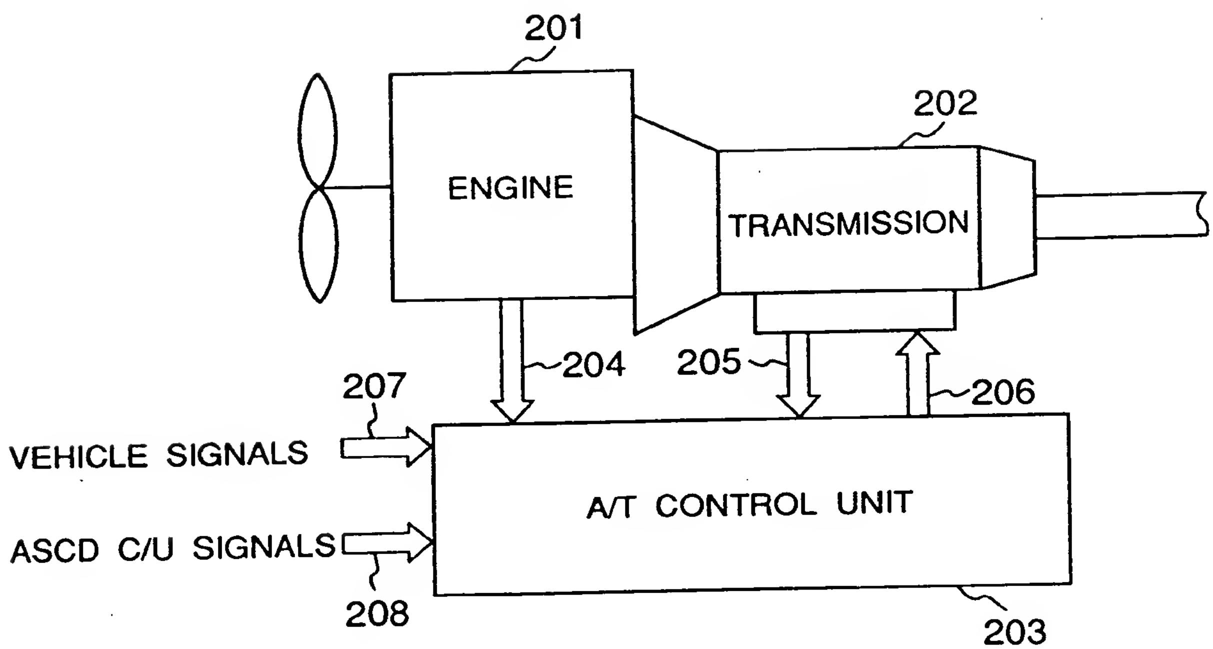
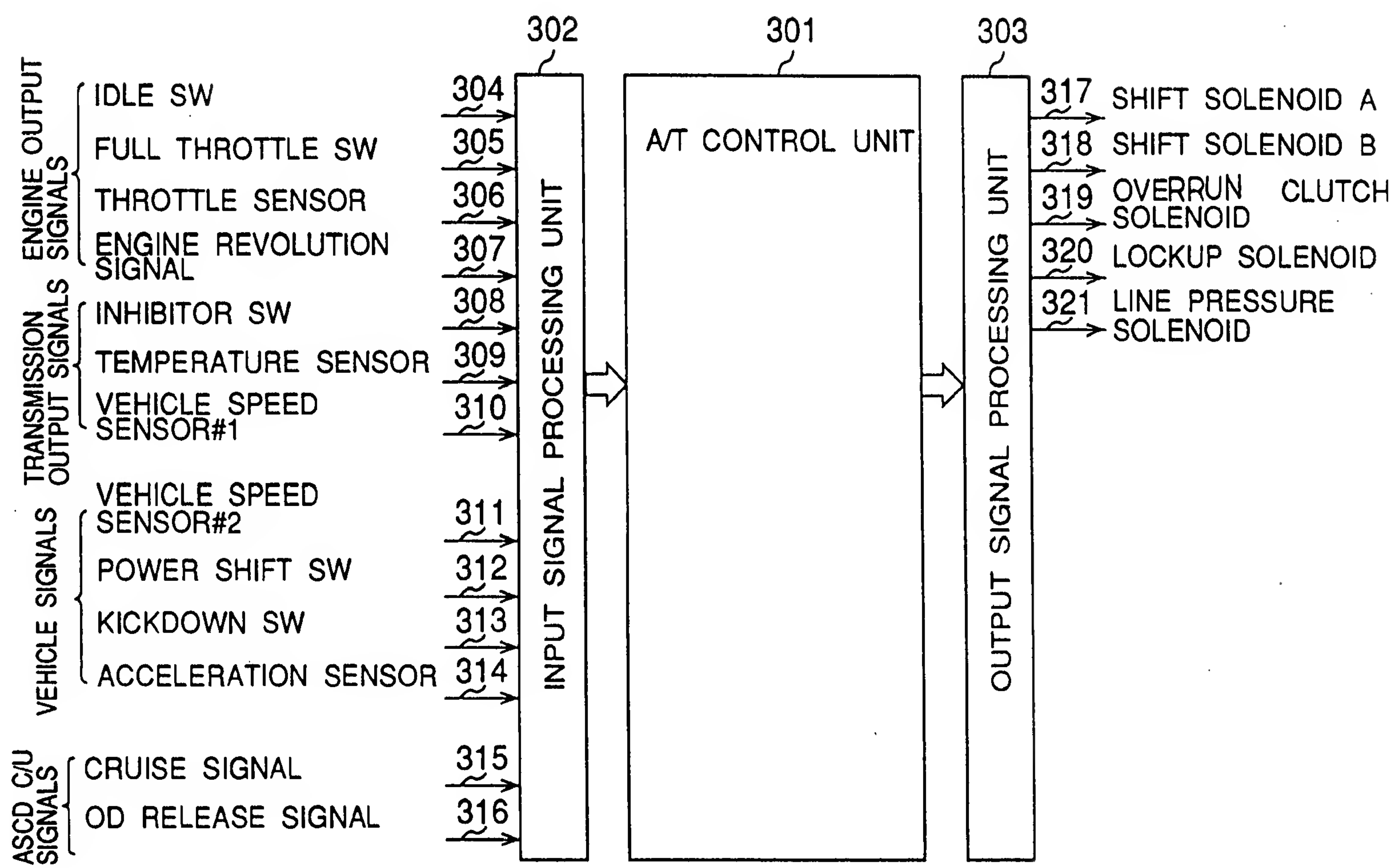
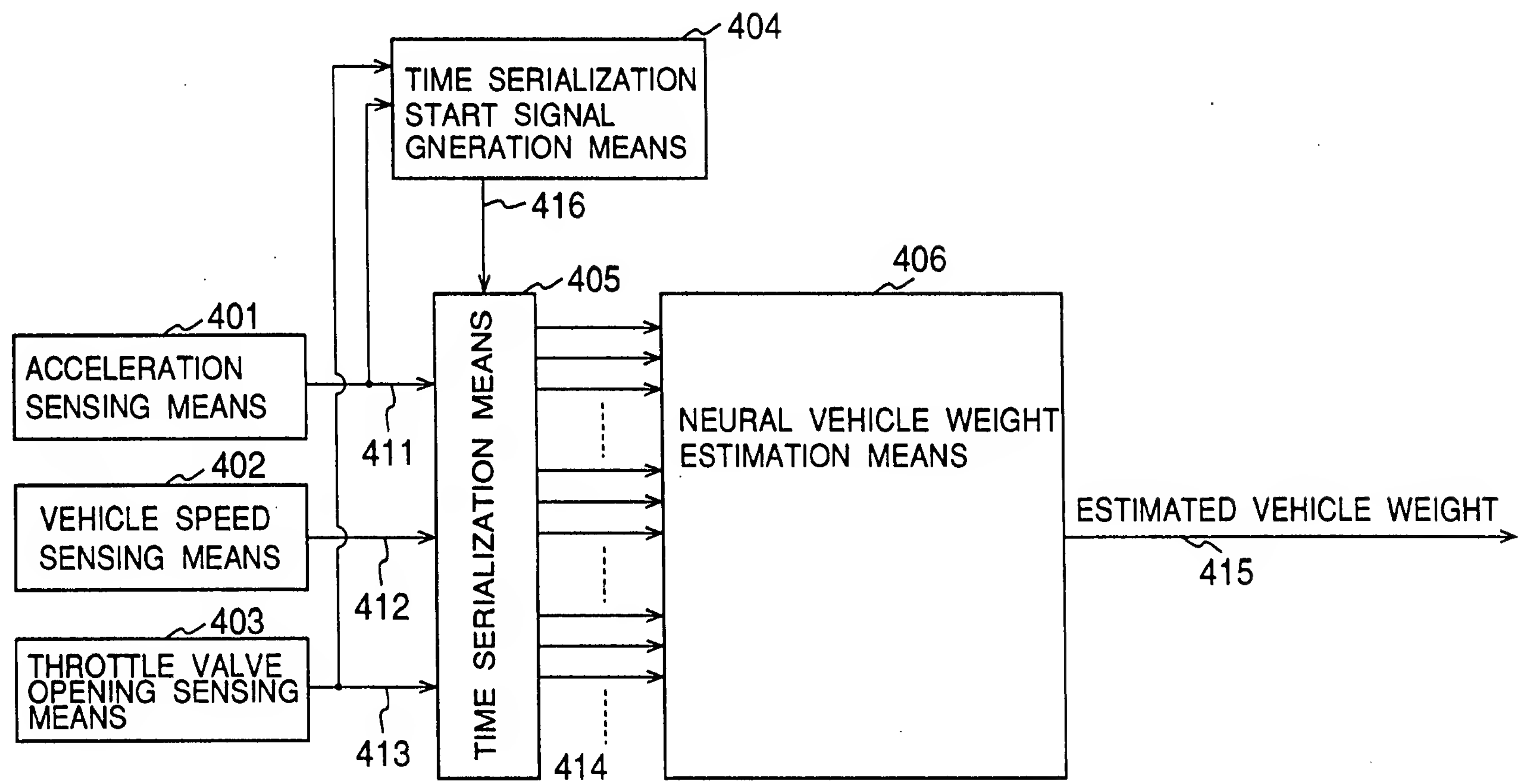

201
202
ENGINE
TRANSMISSION
204
205
206
207
VEHICLE SIGNALS
ASCD C/U SIGNALS
A/T CONTROL UNIT
208
203

FIG.3



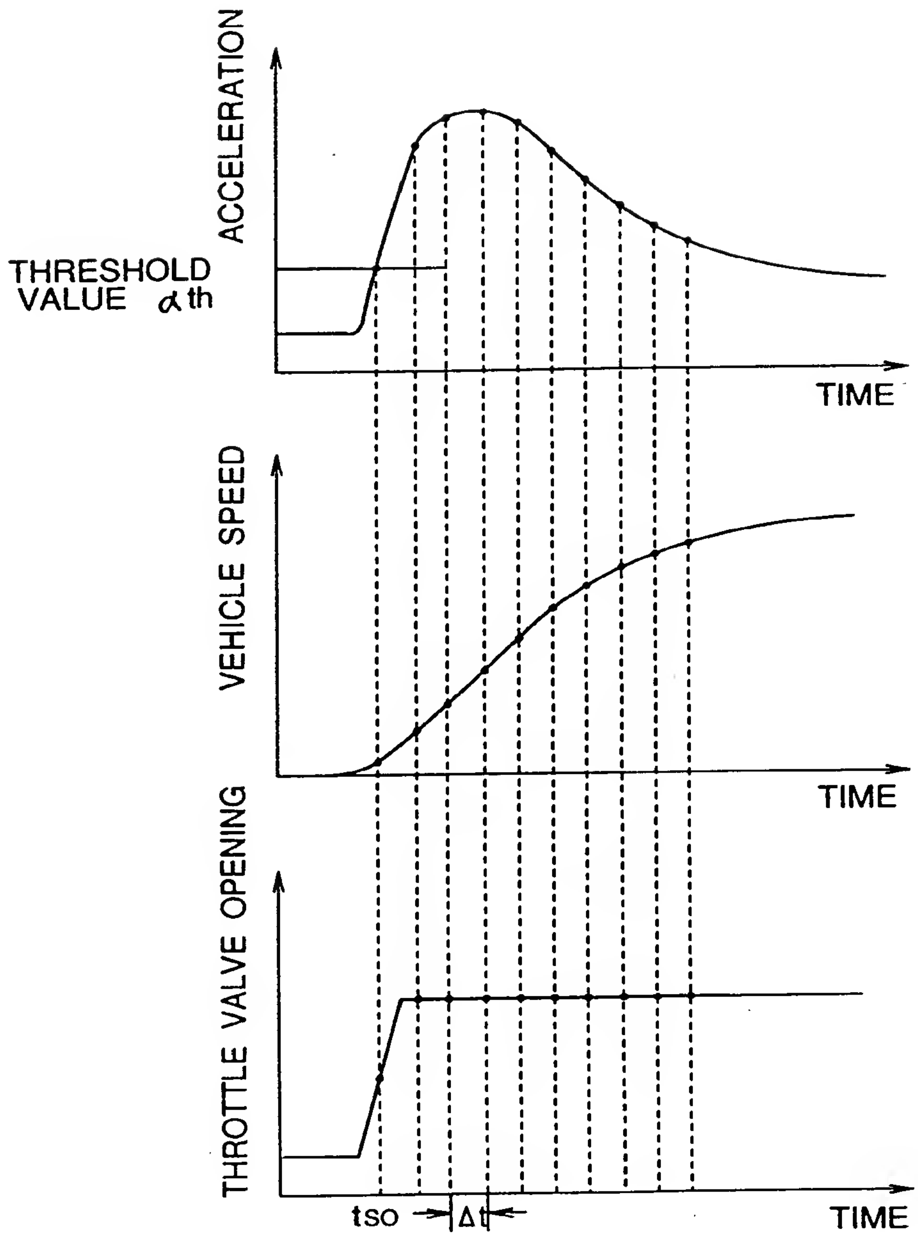
302
301
303
ENGINE OUTPUT SIGNALS
IDLE SW
FULL THROTTLE SW
THROTTLE SENSOR
ENGINE REVOLUTION SIGNAL
TRANSMISSION OUTPUT SIGNALS
INHIBITOR SW
TEMPERATURE SENSOR
VEHICLE SPEED SENSOR#1
VEHICLE SIGNALS
VEHICLE SPEED SENSOR#2
POWER SHIFT SW
KICKDOWN SW
ACCELERATION SENSOR
ASCD C/U SIGNALS
CRUISE SIGNAL
OD RELEASE SIGNAL
304
305
306
307
308
309
310
311
312
313
314
315
316
INPUT SIGNAL PROCESSING UNIT
A/T CONTROL UNIT
OUTPUT SIGNAL PROCESSING UNIT
317 SHIFT SOLENOID A
318 SHIFT SOLENOID B
319 OVERRUN CLUTCH SOLENOID
320 LOCKUP SOLENOID
321 LINE PRESSURE SOLENOID

FIG.4



404
TIME SERIALIZATION START SIGNAL GNERATION MEANS
416
405
406
401
ACCELERATION SENSING MEANS
402
VEHICLE SPEED SENSING MEANS
403
THROTTLE VALVE OPENING SENSING MEANS
411
412
413
TIME SERIALIZATION MEANS
414
NEURAL VEHICLE WEIGHT ESTIMATION MEANS
ESTIMATED VEHICLE WEIGHT
415

FIG.5



ACCELERATION
THRESHOLD VALUE αth
TIME
VEHICLE SPEED
TIME
THROTTLE VALVE OPENING
tso
Δt
TIME

FIG.6 (a)

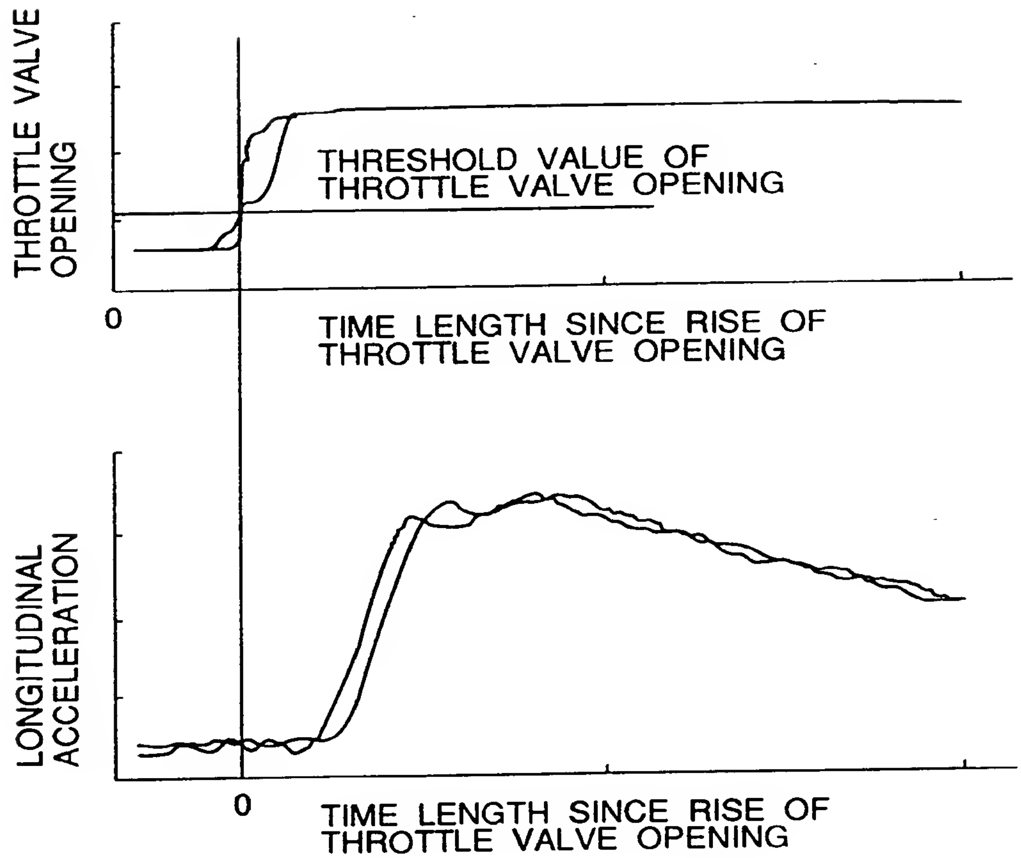

THROTTLE VALVE OPENING
THRESHOLD VALUE OF THROTTLE VALVE OPENING
0
TIME LENGTH SINCE RISE OF THROTTLE VALVE OPENING
LONGITUDINAL ACCELERATION
0
TIME LENGTH SINCE RISE OF THROTTLE VALVE OPENING

FIG.6 (b)

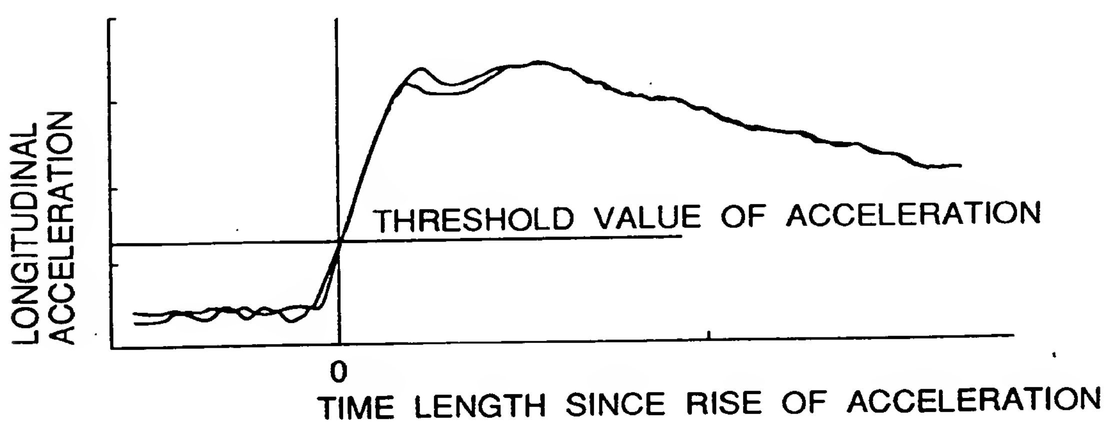
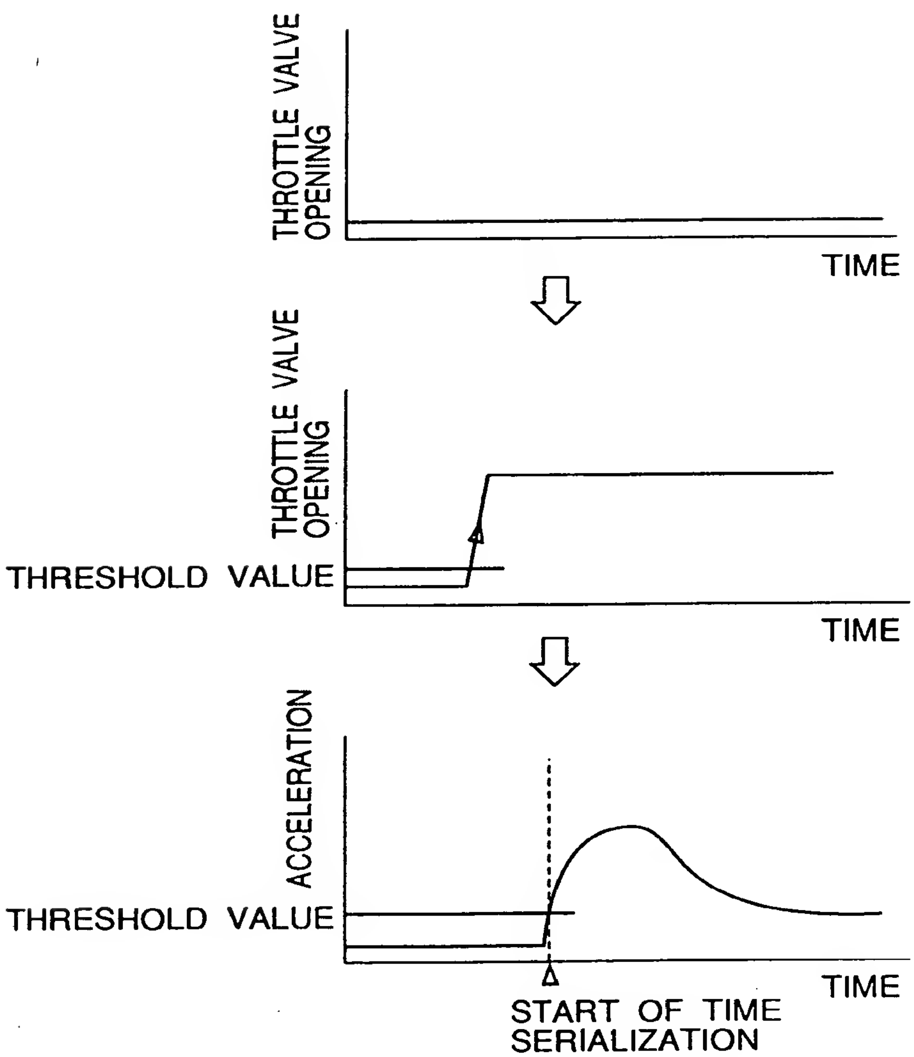

LONGITUDINAL ACCELERATION
THRESHOLD VALUE OF ACCELERATION
0
TIME LENGTH SINCE RISE OF ACCELERATION

FIG.7



THROTTLE VALVE OPENING
TIME
THROTTLE VALVE OPENING
THRESHOLD VALUE
TIME
ACCELERATION
THRESHOLD VALUE
TIME
START OF TIME SERIALIZATION

FIG.8

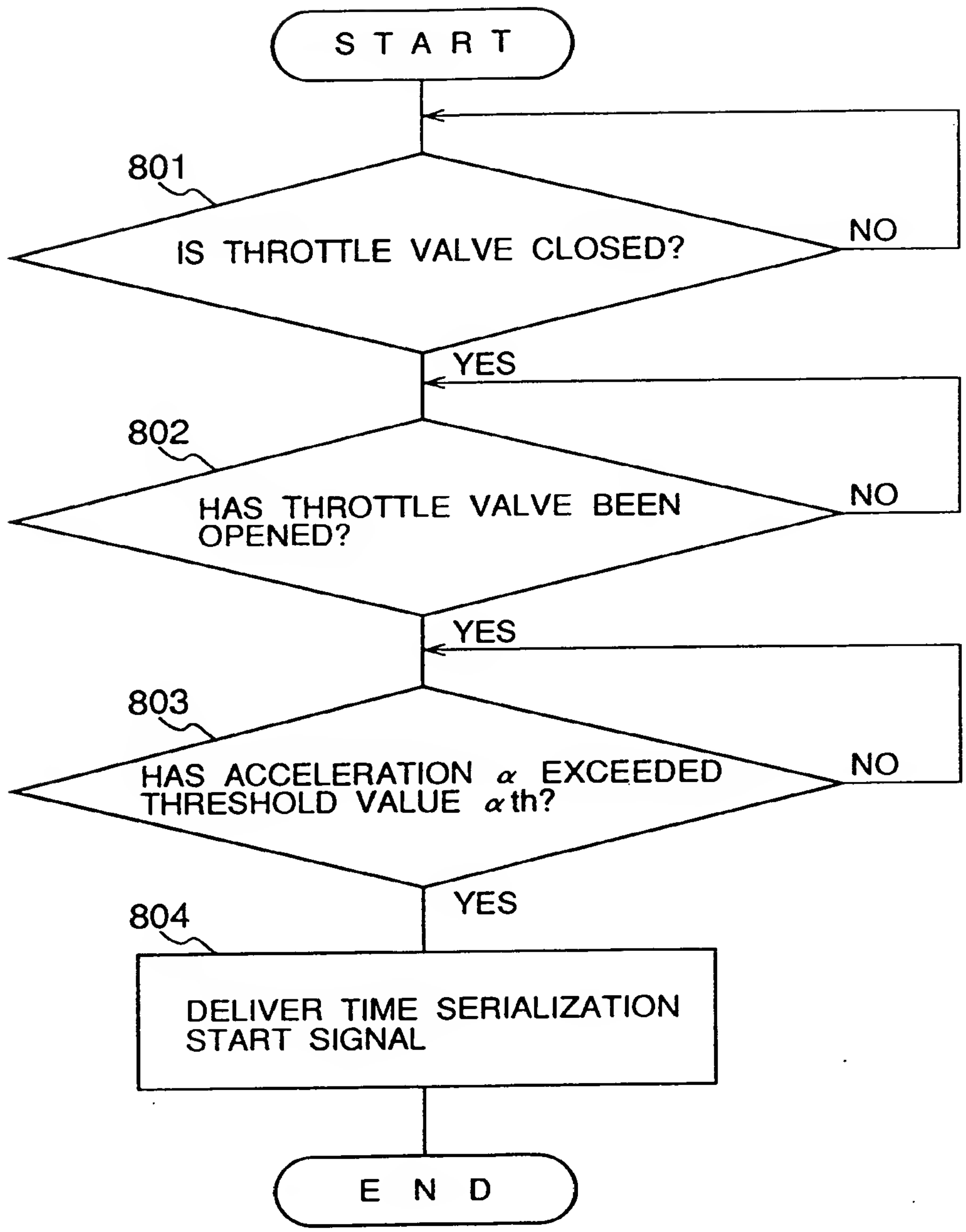
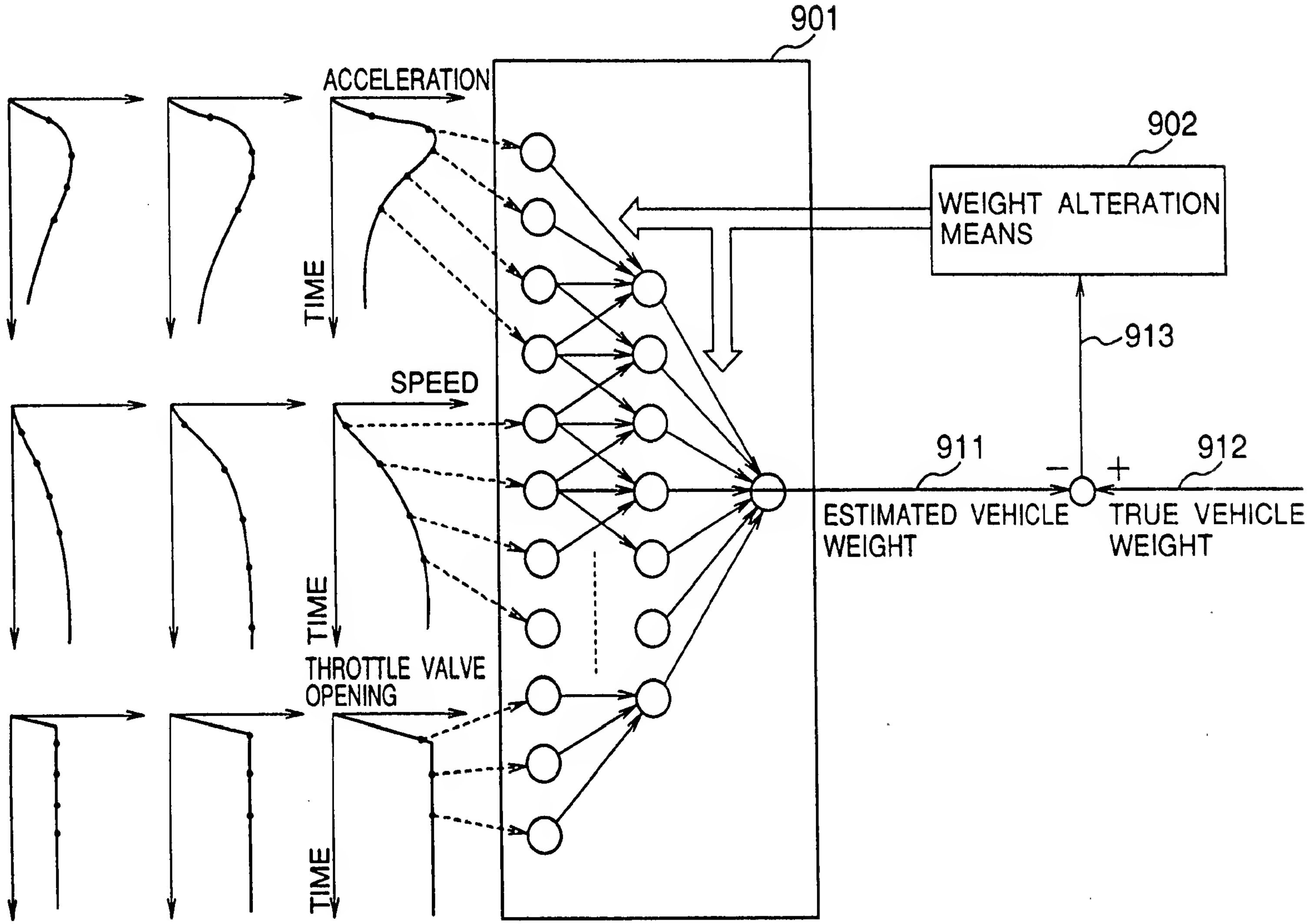
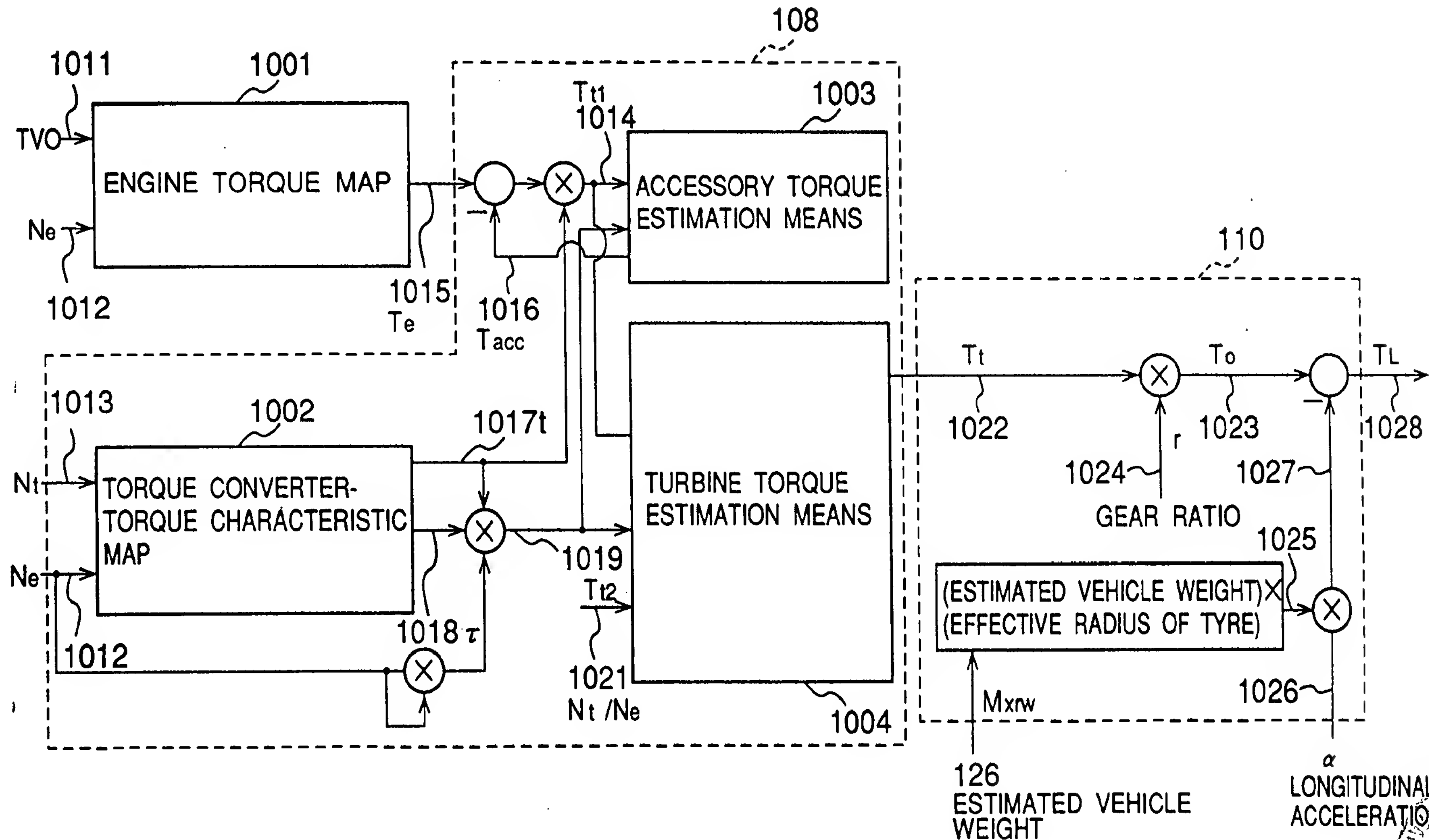

START
801
IS THROTTLE VALVE CLOSED?
NO
YES
802
HAS THROTTLE VALVE BEEN OPENED?
NO
YES
803
HAS ACCELERATION α EXCEEDED THRESHOLD VALUE αth?
NO
YES
804
DELIVER TIME SERIALIZATION START SIGNAL
END

FIG.9



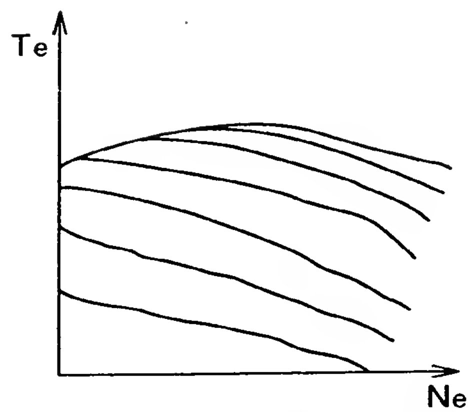
901
902
WEIGHT ALTERATION MEANS
913
911
912
ACCELERATION
SPEED
THROTTLE VALVE OPENING
TIME
TIME
TIME
ESTIMATED VEHICLE WEIGHT
TRUE VEHICLE WEIGHT
−
+

FIG.10



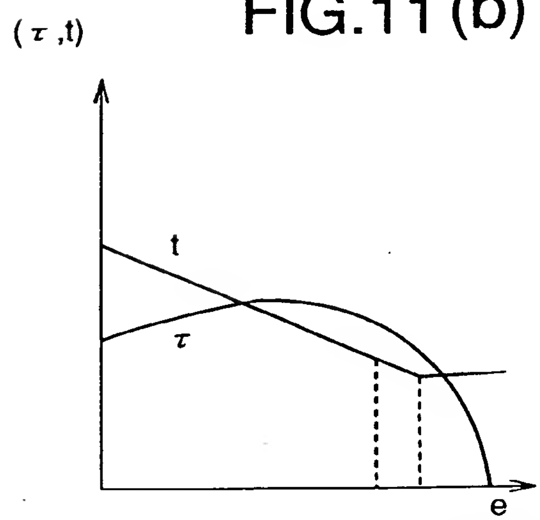
108
1011
1001
TVO
ENGINE TORQUE MAP
Ne
1012
1015
Te
1016
Tacc
Tt1
1014
1003
ACCESSORY TORQUE ESTIMATION MEANS
1013
1002
Nt
TORQUE CONVERTER-TORQUE CHARACTERISTIC MAP
Ne
1012
1017t
1018 τ
1019
Tt2
1021
Nt /Ne
TURBINE TORQUE ESTIMATION MEANS
1004
110
Tt
1022
To
1023
TL
1028
r
1024
GEAR RATIO
1027
1025
(ESTIMATED VEHICLE WEIGHT)X(EFFECTIVE RADIUS OF TYRE)
Mxrw
1026
126
ESTIMATED VEHICLE WEIGHT
α
LONGITUDINAL ACCELERATION

FIG.11 (a)



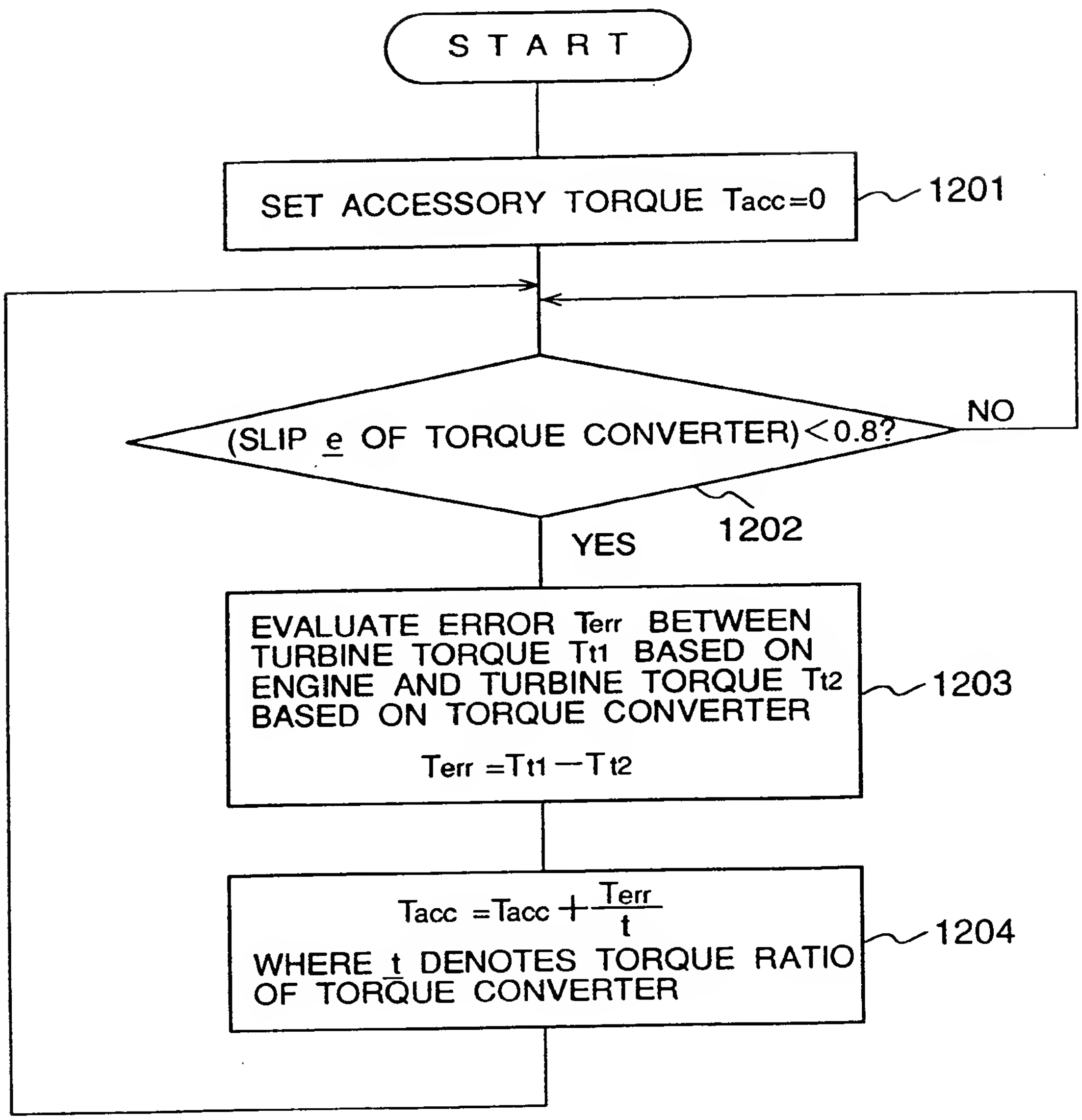
ENGINE TORQUE MAP

FIG.11 (b)



TORQUE CONVERTER CHARACTERISTIC MAP

FIG.12



START
SET ACCESSORY TORQUE Tacc=0
1201
(SLIP e OF TORQUE CONVERTER)<0.8?
NO
YES
1202
EVALUATE ERROR Terr BETWEEN TURBINE TORQUE Tt1 BASED ON ENGINE AND TURBINE TORQUE Tt2 BASED ON TORQUE CONVERTER
Terr =Tt1 −Tt2
1203
Tacc =Tacc + Terr/t
WHERE t DENOTES TORQUE RATIO OF TORQUE CONVERTER
1204

FIG.13

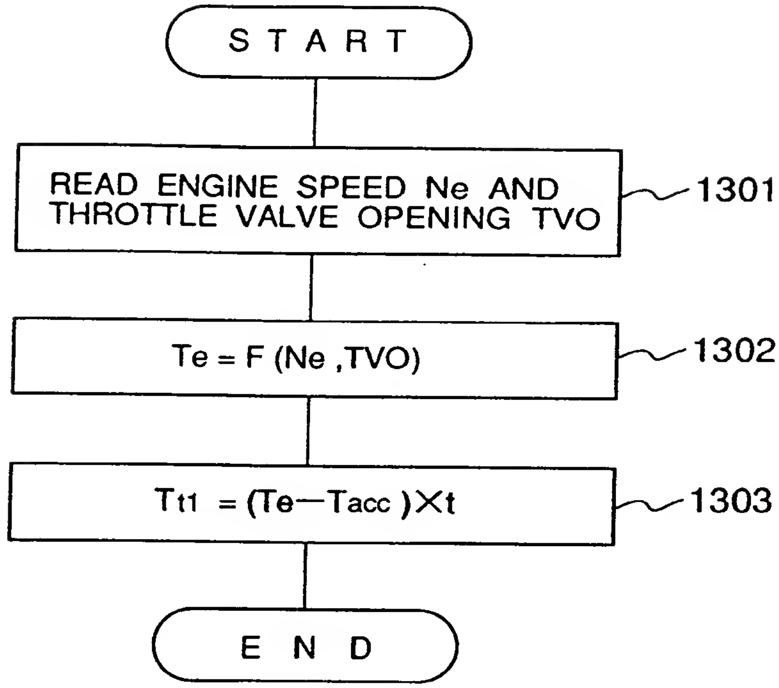

START
READ ENGINE SPEED Ne AND THROTTLE VALVE OPENING TVO
1301
Te = F (Ne ,TVO)
1302
Tt1 = (Te—Tacc)×t
1303
END

FIG.16

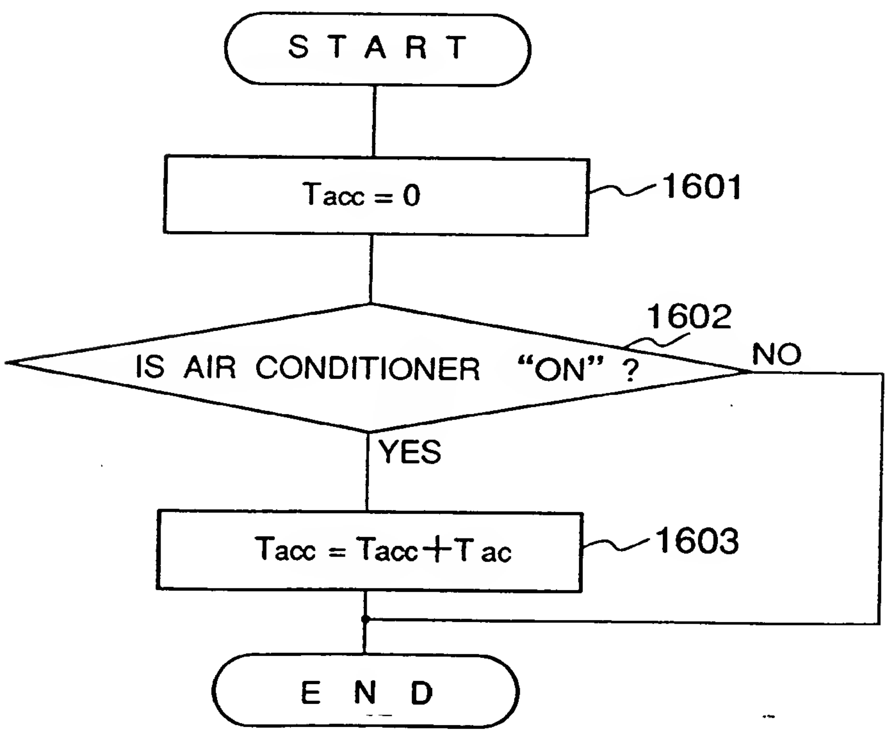

START
Tacc = 0
1601
IS AIR CONDITIONER “ON” ?
1602
NO
YES
Tacc = Tacc+T ac
1603
END

FIG.14

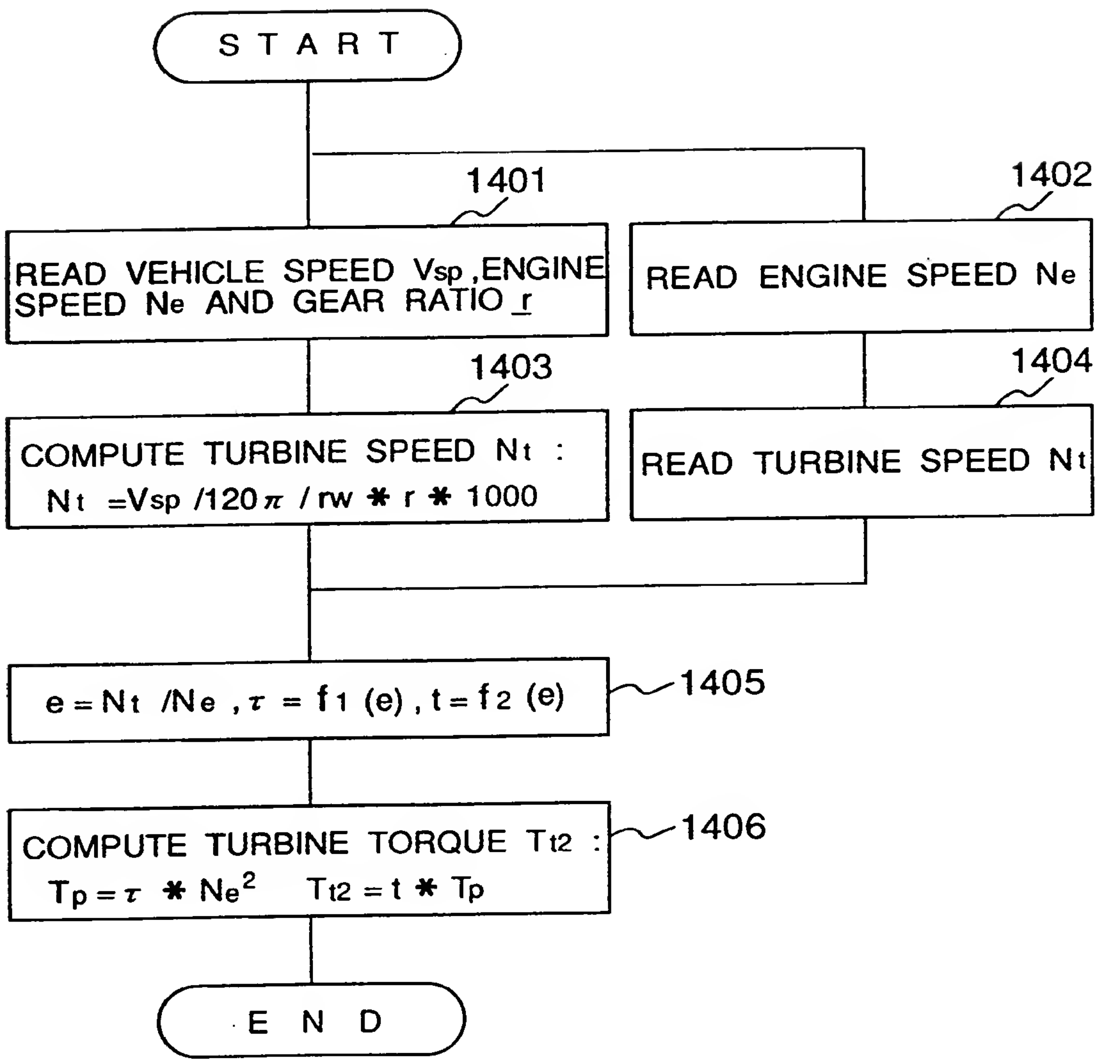
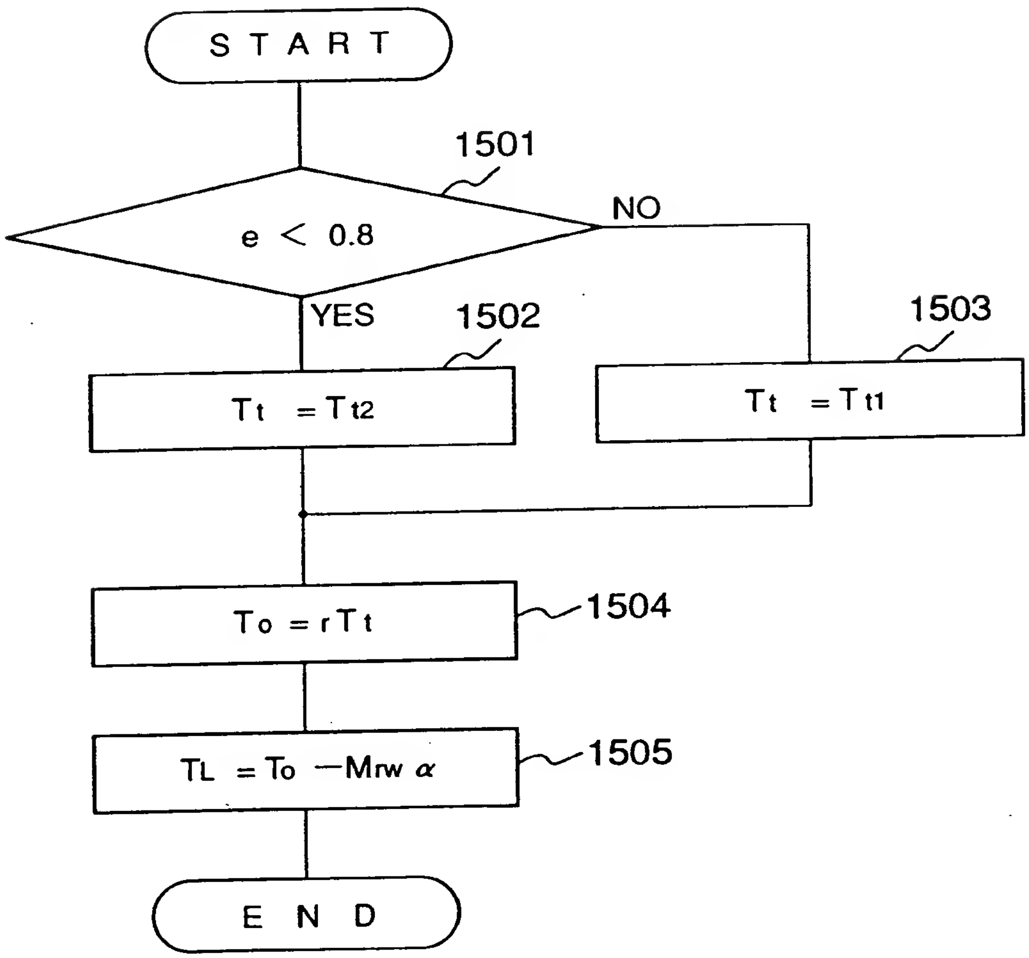

START
1401
READ VEHICLE SPEED Vsp ,ENGINE SPEED Ne AND GEAR RATIO r
1402
READ ENGINE SPEED Ne
1403
COMPUTE TURBINE SPEED Nt :
Nt =Vsp /120π / rw ✱ r ✱ 1000
1404
READ TURBINE SPEED Nt
1405
e = Nt /Ne , τ = f1 (e) , t = f2 (e)
1406
COMPUTE TURBINE TORQUE Tt2 :
Tp = τ ✱ Ne²   Tt2 = t ✱ Tp
END

FIG.15



START
1501
e < 0.8
NO
YES
1502
1503
Tt = Tt2
Tt = Tt1
To = rTt
1504
TL = To −Mrw α
1505
END

【図１６】

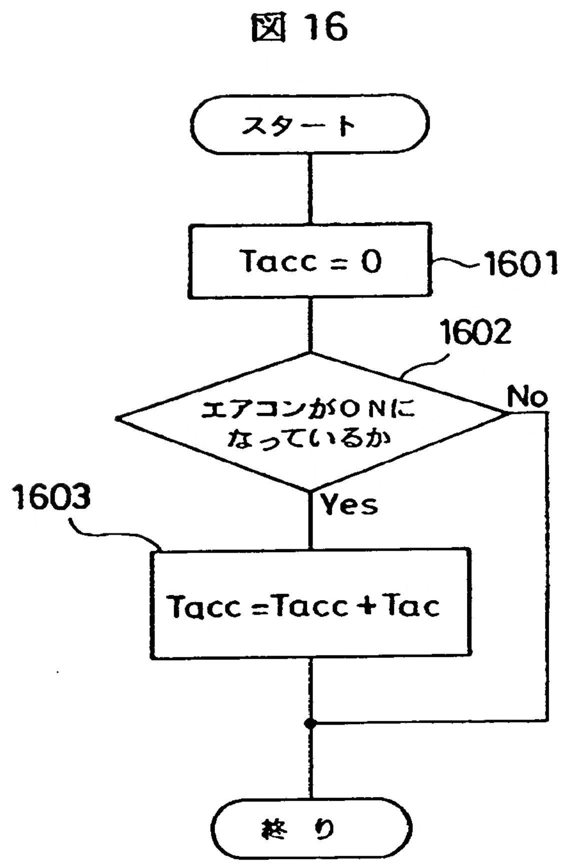
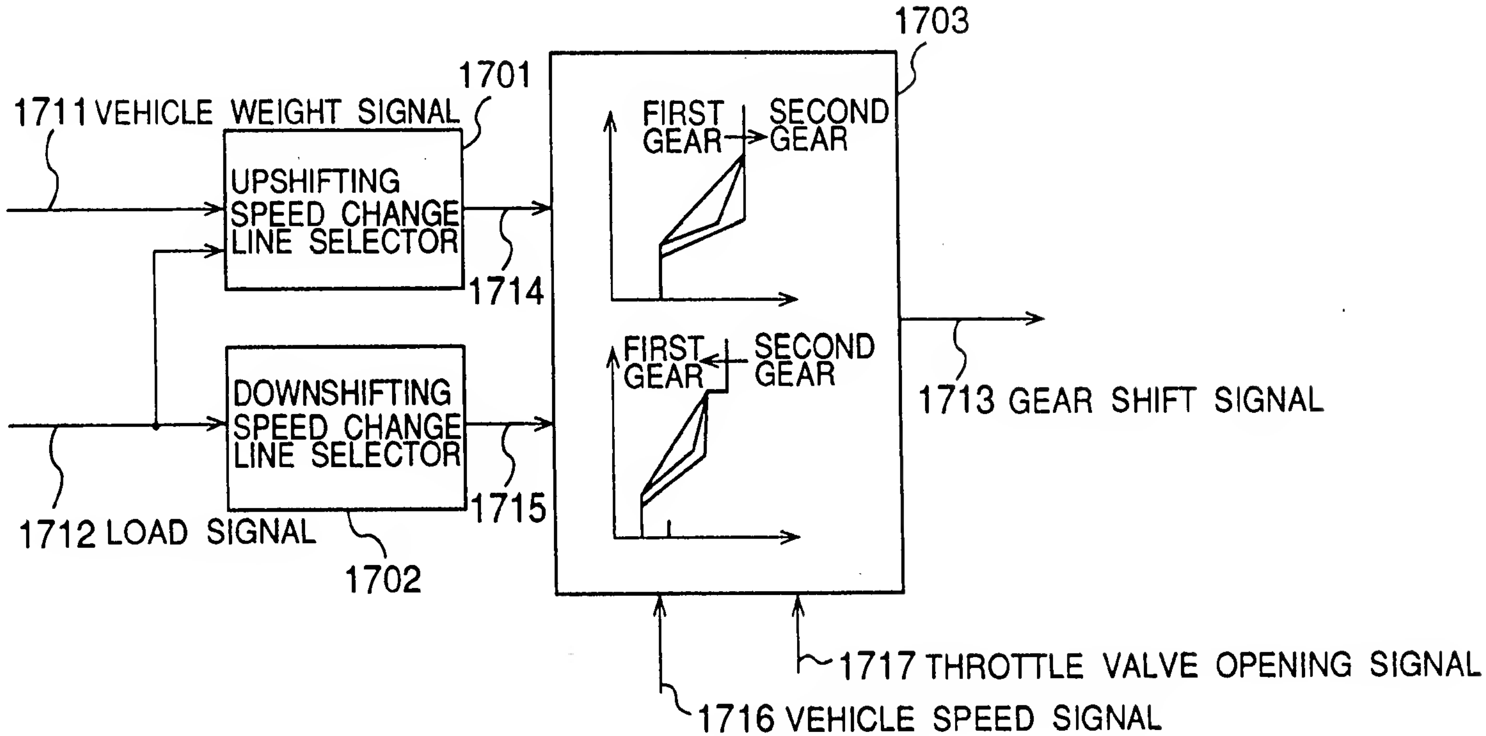


図 16
スタート
Tacc = 0
1601
1602
エアコンがＯＮになっているか
No
Yes
1603
Tacc =Tacc + Tac
終り

FIG.17



1711 VEHICLE WEIGHT SIGNAL
1701
UPSHIFTING SPEED CHANGE LINE SELECTOR
1714
1712 LOAD SIGNAL
DOWNSHIFTING SPEED CHANGE LINE SELECTOR
1715
1702
1703
FIRST GEAR
SECOND GEAR
FIRST GEAR
SECOND GEAR
1713 GEAR SHIFT SIGNAL
1717 THROTTLE VALVE OPENING SIGNAL
1716 VEHICLE SPEED SIGNAL

FIG.18 (a)

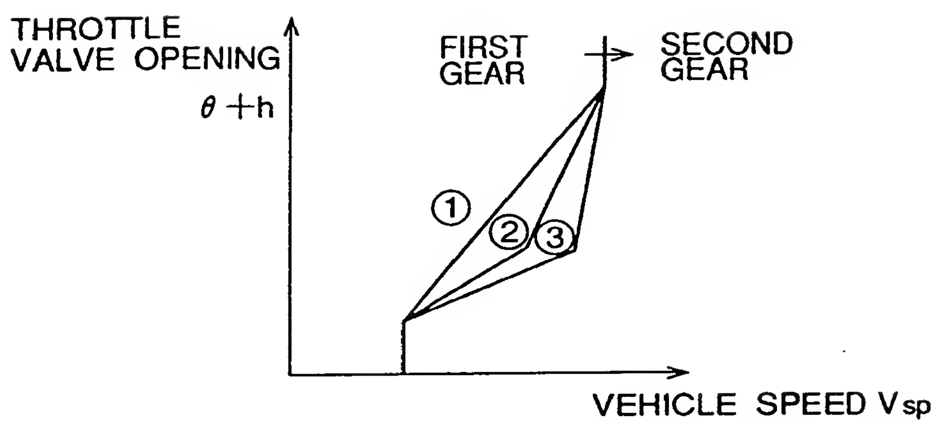


FIG.18 (b)

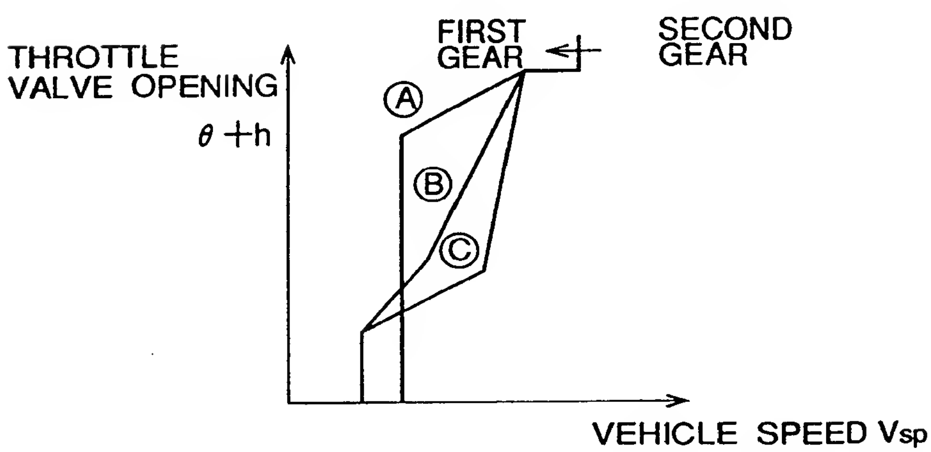
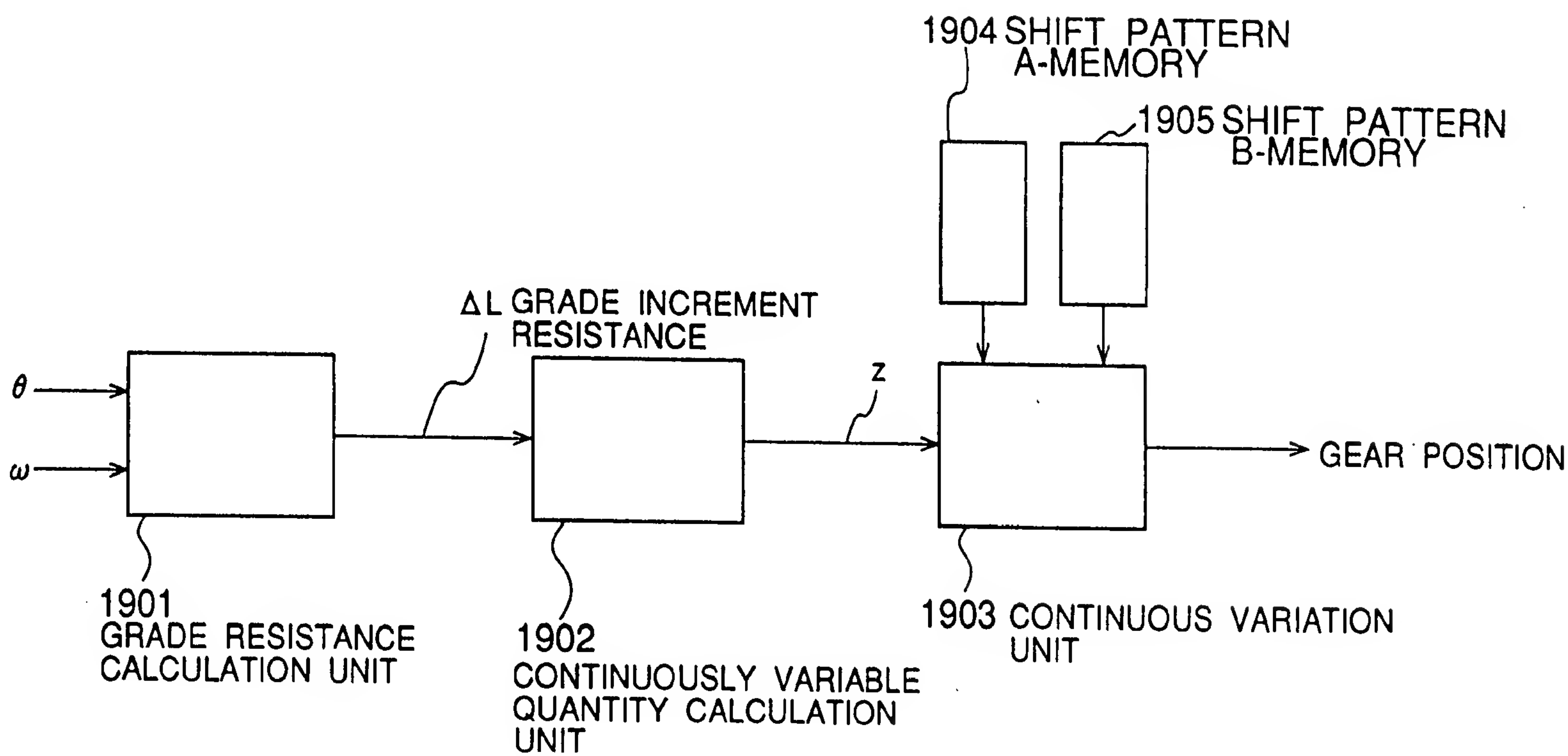
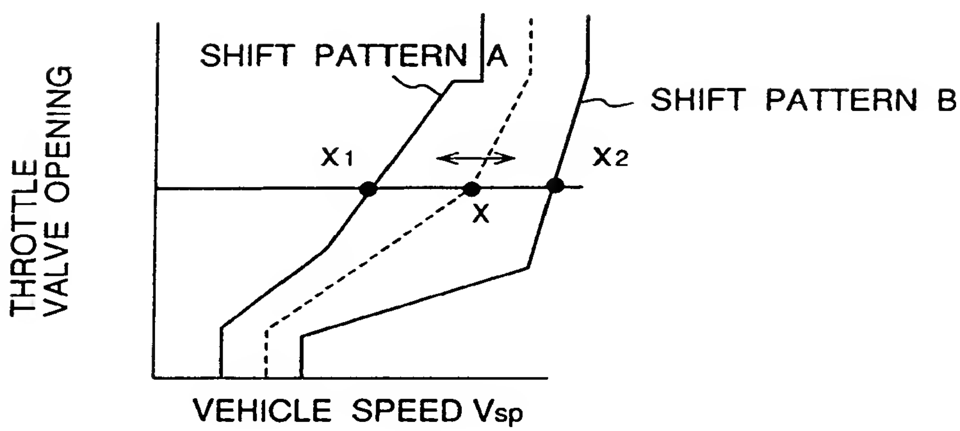


FIG.19



θ
ω
1901
GRADE RESISTANCE CALCULATION UNIT
ΔL GRADE INCREMENT RESISTANCE
1902
CONTINUOUSLY VARIABLE QUANTITY CALCULATION UNIT
z
1903 CONTINUOUS VARIATION UNIT
1904 SHIFT PATTERN A-MEMORY
1905 SHIFT PATTERN B-MEMORY
GEAR POSITION

FIG.20



SHIFT PATTERN A
SHIFT PATTERN B
THROTTLE VALVE OPENING
X1
X
X2
VEHICLE SPEED Vsp

FIG.21(a)

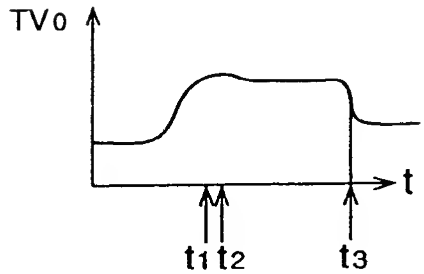


FIG.21(b)

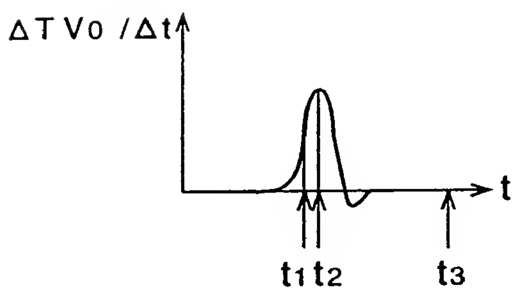
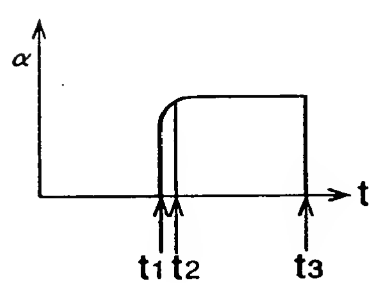


FIG.21(c)



Attachment 1.d

ATTORNEY DOCKET NO. 381/41092
PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Hiroshi ONISHI et al.

Appln. No.: Not yet assigned Group Art Unit:

Filed: December 3, 1992 Examiner:

For: AUTOMATIC TRANSMISSION CONTROL SYSTEM FOR AN AUTOMOBILE

PRELIMINARY AMENDMENT

BOX NON-FEE AMENDMENT
Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

December 3, 1992

Sir:

Please enter the following amendment to the specification prior to the examination of the application.

IN THE SPECIFICATION:

Page 5, after line 4, insert the following paragraph:

-- Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.--.

Page 20, line 15, after "TVO" insert --are read--.

Page 21, line 25, delete "If" and insert --Whether--; and

line 26, delete "," after "0.8".

Page 24, line 1, delete "moves" and insert --follows--;

line 2, delete "along", delete "and" (first occurrence) and insert --or-- therein, delete "as" and insert --dependent

on--, and after "load" insert --, moving from line 1 → 2 → 3 as such weight and speed increase.--;

line 3, delete "enlarge"; and

line 4, delete "along" and insert --between-- therein.

Page 28, after line 14, insert the following paragraph:

-- Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.--.

IN THE CLAIMS:

Please amend the claims as follows and add new Claims 22-26 as follows:

Claim 1, line 3, delete "a" and insert --an automobile--; and

line 6, delete "with reference to" and insert --based on--.

Claim 2, line 3, delete "with"; and

line 4, delete "reference to," and insert --in response to-- and also delete ", the".

Claim 3, line 5, delete "with reference to," and insert --in response to-- and also delete ", the"; and

line 6, delete "said" and insert --a-- and delete "further" and insert --by--.

Claim 4, line 3, delete "with" and insert --in--; and

line 4, delete "reference" and insert --response--.

Claim 5, line 4, after "over" insert --between--.

Claim 6, line 3, delete "has been supplied" and insert --receives";

line 4, delete "with values of, at least," and insert --values of at least-- therein;

line 6, delete "supplied values" and insert --values supplied--;

line 7, delete "being" and insert --comprising--;

line 9, after "automobile;" insert --and--; and

line 11, delete "," (both occurrences).

7. (Amended) An automatic transmission control system for an automobile as defined in Claim 6, wherein said vehicle weight estimation means [supplies] <u>includes means for supplying</u> said time-serial signals of said throttle valve opening and said acceleration<u>, commencing when</u> [at a timing at which] said throttle valve opening has exceeded a predetermined value and [at which] said acceleration has also exceeded a predetermined value.

Claim 8, line 4, delete "dependency on" and insert --response to--.

Claim 9, line 4, delete "dependency on," and insert --response to--; and

line 5, delete ",".

Claim 10, line 4, delete "dependency on" and insert --response to--; and

line 5, delete "running" and after "automobile", insert --when it is in motion--.

Claim 11, line 4, delete "dependency on" and insert --response to--; and

line 5, delete "running" and insert --when it is in motion--.

Claim 12, line 3, delete "is" and insert --comprises--;

line 7, delete "accepting" and insert --receiving--;

line 11, delete "accepted" and insert --received--;

line 12, delete "is" and insert --comprises--; and

line 15, delete "determining" and insert --selecting--.

13. (Amended) An automatic transmission control system for an automobile as defined in Claim 12, wherein:

said vehicle weight estimation means estimates said vehicle weight of said automobile [by accepting] in response to a throttle valve opening signal and a vehicle speed signal in addition to said acceleration signal;

said torque estimation means estimates said output torque [by accepting] in response to a revolution speed signal of an engine of said drive train and a turbine revolution speed signal of a torque converter of said automatic transmission; and

said running load estimation means estimates said running load [from] in response to said acceleration signal, said estimated vehicle weight and the estimated output torque.

Claim 14, line 9, delete "dependency on" and insert --response to--.

Claim 16, line 7, delete "accepting" and insert --receiving--;

line 8, after "acceleration" insert --signal--;

line 11, delete "input acceleration" and insert --received acceleration signal--.

Claim 21, line 1, change "21" to --17--.

IN THE ABSTRACT:

Line 4, delete "(106";

line 5, delete "in Fig. 1)"

line 6, delete ";" and "(107, 1001)";

line 7, delete "(102)";

line 9, delete "(110)"; and

line 13, delete "(109)".

Please add the following new claims:

--18. Method of controlling an automatic transmission for an automobile having means for storing a plurality of shift schedules for said automatic transmission, said method comprising the steps of:

first, calculating a value for an automobile load of said automobile and generating an automobile load signal indicative thereof;

second, calculating a value for an output torque of said transmission based on torque characteristics of a drive train of said automobile and generating an output torque signal indicative of said output torque value;

third, estimating a running load of said automobile based on said automobile load signal and said output torque signal; and

fourth, selecting a shift schedule from among a plurality of shift schedules stored in said means for storing, based on the estimated running load.

19. Method according to Claim 18, wherein said second step comprised calculating said output torque based on at least torque characteristics of a torque converter of said automatic transmission.

20. Method according to Claim 18, wherein said second step comprises calculating said output torque based on at least torque characteristics of a torque converter of said automatic transmission, and those of an engine of said drive train.

21. Method according to Claim 18, wherein said second step comprises calculating said output torque based on torque characteristics of an engine of said drive train when a ratio between an input revolution speed and an output revolution speed is greater than a predetermined value, and calculating said

output torque based on torque characteristics of a torque converter of said automatic transmission when said ratio is less than said predetermined value.

22. Method according to Claim 20, wherein said second step comprises calculating said output torque based on torque characteristics of an engine of said drive train when a ratio between an input revolution speed and an output revolution speed is greater than a predetermined value, and calculating said output torque based on torque characteristics of a torque converter of said automatic transmission when said ratio is less than said predetermined value.

REMARKS

Entry of the amendment to the Specification, Abstract and Claims, before examination of the application is respectfully requested.

If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

It is respectfully requested that, if necessary to effect a timely response, this paper be considered as a Petition for an Extension of Time sufficient to effect a timely response and shortages in other fees, be charged, or any overpayment in fees be credited, to the Account of Evenson, Wands, Edwards, Lenahan & McKeown, Deposit Account No. 05/1323 (381/41092).

Respectfully submitted,

EVENSON, WANDS, EDWARDS,
LENAHAN & McKEOWN

Donald D. Evenson
Registration No. 26,160

GRE/DDE:cvl
(202) 628-8800

Attachment 1.c

07/985199

MAIL ROOM FEB 19 1993 43 PAT. & TRADEMARK OFF.

MAIL ROOM DEC 1? 1992 52 PAT. & TRADEM...

日本国特許庁
PATENT OFFICE
JAPANESE GOVERNMENT

紙添付の書類に記載されている事項は下記の出願書類に記載されて
事項と同一であることを証明する。

is to certify that the annexed is a true copy of the following application as filed
is Office.

願年月日 of Application:	1991年12月　3日
願番号 ation Number:	平成　3年特許願第319205号
願人 nt (s):	株式会社日立製作所

1992年10月30日

特許庁長官
Commissioner,
Patent Office

麻生渡

出証平　04－063184

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【整理番号】　HA05679000
【提出日】　平成 3年12月 3日
【あて先】　特許庁長官　殿
【国際特許分類】　F16H 59/66
F16H 59/52
F16H 59/60
【発明の名称】　自動車の自動変速制御装置
【請求項の数】　6
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【識別番号】　100087170

【弁理士】

【氏名又は名称】　富田　和子

【手数料の表示】

【納付方法】　予納

【予納台帳番号】　012014

【納付金額】　14,000円

【提出物件の目録】

【物件名】　明細書　1

【物件名】　図面　1

【物件名】　要約書　1

【包括委任状番号】　9003111

【プルーフの要否】　要

【書類名】　明細書
【発明の名称】　自動車の自動変速制御装置
【特許請求の範囲】
【請求項1】
自動車の車重の推定を行なう車重推定手段と、
出力トルクの推定を行なうトルク推定手段と、
加速度信号を受付ける加速度入力手段と、
得られた車重、出力トルク、加速度から走行負荷を推定する負荷推定手段と、
複数の変速スケジュールの記憶手段と、
得られた車重と走行負荷に応じて上記変速スケジュールから一つを選択し、選
された変速スケジュールに従ってギア位置の決定を行なうギア位置決定手段と
有することを特徴とする自動車の自動変速制御装置。
【請求項2】
請求項1記載の自動車の自動変速制御装置において、
記車重推定手段は、スロットル開度信号、加速度信号、車速信号を受付けて
動車の車重の推定を行ない、
記トルク推定手段は、エンジン回転数信号、トルクコンバータのタービン回
信号を受付けて、出力トルクを推定し、
記負荷推定手段は、加速度信号および得られた車重、出力トルクから、負荷
定することを特徴とする自動車の自動変速制御装置。
【請求項3】
求項1または2記載の自動車の自動変速制御装置において、
記トルク推定手段は、トルクコンバータの回転比により、タービン回転数と
ジン回転数から出力トルクを推定するモードと、エンジンのスロットル開度
ジン回転数から出力トルクを推定するモードとを有することを特徴とする
の自動変速制御装置。
【請求項4】
項1、2または3記載の自動車の自動変速制御装置において、
負荷推定手段は、自動車の車重、出力トルク、加速度から運動方程式を解

負荷を推定することを特徴とする自動車の自動変速制御装置。

【請求項5】

…車重の測定を行なう車重測定手段と、

…クの推定を行なうトルク推定手段と、

…受付ける加速度入力手段と、

…車重、出力トルク、加速度から走行負荷を推定する負荷推定手段と、

…速スケジュールの記憶手段と、

…車重と走行負荷に応じて上記変速スケジュールから一つを選択し、選

…速スケジュールに従ってギア位置の決定を行なうギア位置決定手段と

…とを特徴とする自動車の自動変速制御装置。

【請求項6】

…、2、3、4または5記載の自動車の自動変速制御装置において、

…号を受付けるときに、加速度信号の立ち上がりに同期して受付け開始

…する開始信号発生手段を有することを特徴とする自動車の自動変速制

…細な説明】

【0001】

【産業上の利用分野】

…自動車の変速制御装置に関する。

【0002】

【従来の技術】

…変速制御装置は、車速及びスロットル開度を電気信号として検知し、

…ロットル開度を変数としてあらかじめ設定されている変速パターンに

…現在の車速及びスロットル開度に対応する所定の変速段を選択する。

…ンは複数組設定されており、運転者の操作により選択される。

【0003】

…速パターンの選択は運転者の運転操作から自動的に切り替えるように

…ある。

０４】
解決しようとする課題】
機の制御は車速及びスロットル開度を変数としてあらかじめ設定さ
パターンに基づいて、現在の車速及びスロットル開度に対応する所
を選択するようにしてある。
０５】
では運転状況の変動特に走行負荷の変化に対して的確な変速を行うこ
あった。たとえば平坦路または緩い下り坂では、登り坂に比べて早め
ップすることにより運転を損なわずしかも燃費が向上すると考えられ
はアクセル開度と車速のみから変速を行っていたので、このような変
かった。
００６】
加速の際の車重による加速特性の変化に対応するように変速制御を行
両の軽量化に伴って重要となる。そこで走行負荷ならびに車重を推定
際には車重ならびに走行負荷によって変速パターンを変化させ、また
も走行負荷に応じて変速パターンを変えることによって、燃費が向上
況に応じた的確な変速が行えると考えられる。
００７】
に、従来技術は、変速パターンが代表的な２～３の運転状況に基づいて
ているため、運転状況を的確に反映した変速が行えない場合があった。
燃費の悪化をまねくことが多かった。本発明の目的は、走行負荷を推定
及び走行負荷にあわせた変速を実行する自動車の自動変速制御装置を提
とである。
【０００８】
題を解決するための手段】
的を達成するために、本発明は自動車の自動変速制御装置において、自
重の推定を行なう車重推定手段と、出力トルクの推定を行なうトルク推
、加速度信号を受付ける加速度入力手段と、得られた車重、出力トルク
度から走行負荷を推定する負荷推定手段と、複数の変速スケジュールの記

段と、得られた車重と走行負荷に応じて上記変速スケジュールから一つを選択し、選択された変速スケジュールに従ってギア位置の決定を行なうギア位置決定手段とを有するするようにしたものである。

【0009】

【作用】

自動車の自動変速制御装置において、車重推定手段は、自動車の車重の推定を行なう。トルク推定手段は、出力トルクの推定を行なう。加速度入力手段は、加速度信号を受付ける。負荷推定手段は、得られた車重、出力トルク、加速度から走行負荷を推定する。記憶手段は、複数の変速スケジュールを記憶する。ギア位置決定手段は、得られた車重と走行負荷に応じて上記変速スケジュールから一つを選択し、選択された変速スケジュールに従ってギア位置の決定を行なう。

【0010】

【実施例】

以下本発明の実施例を図に従って説明する。なお以下の説明では変速比またはギア比はトランスミッションのギア比とファイナルギア比をかけたものとする。本発明の構成の概略を図１に示す。

【0011】

スロットル開度を検知するスロットル開度検知手段１０１からはスロットル開度１２１が、車重推定手段１０６およびエンジン発生トルク推定手段１０８およびギア位置決定手段１０９に出力される。

【0012】

加速度を検知する加速度検知手段１０２からは加速度１２２が車重推定手段１０６および負荷推定手段１１０に出力される。

【0013】

車速を検知する車速検知手段１０３からは車速１２３が車重推定手段１０６およびギア位置決定手段１０９に出力される。

【0014】

エンジン回転数を検知するエンジン回転数検知手段１０４からはエンジン回転数１２４がトルクコンバータ発生トルク推定手段１０７およびエンジン発生トル

推定手段１００１に出力される。トルクコンバータ発生トルク推定手段１０７よびエンジン発生トルク推定手段１０８は、トルク推定手段である。

【００１５】

タービン回転数を検知するタービン回転数検知手段１０５からはタービン回転１２５がトルクコンバータ発生トルク推定手段１０７に出力される。

【００１６】

車重推定手段１０６ではスロットル開度１２１、加速度１２２、車速１２３をとにして車重の推定が行われ、推定された車重１２６はギア位置決定手段１０および負荷推定手段１１０に出力される。

【００１７】

トルクコンバータ発生トルク推定手段１０７ではエンジン回転数１２４、ターン回転数１２５からトルクコンバータの発生トルクの推定が行われる。推定さ たトルクコンバータの発生トルク１０２２は負荷推定手段１１０に出力される

【００１８】

エンジン発生トルク推定手段１００１ではスロットル開度１２１、エンジン回数１２４からエンジン発生トルク１０１５の推定が行われる。推定されたエンン発生トルク１０１５はトルクコンバータ発生トルク推定手段１０７に出力さる。

【００１９】

負荷推定手段１１０では推定車重１２６、トルクコンバータの推定発生トルク１２２から負荷トルクの推定が行われる。推定された負荷トルク１２８はギア置決定手段１０９に出力される。

【００２０】

ギア位置決定手段（変速スケジュールの記憶手段でもある）１０９ではスロッル開度１２１、車速１２３、車重１２６、負荷トルク１０２８をもとにギア位１２９の決定が行われる。決定されたギア位置１２９は油圧駆動手段１１１にされる。

【0021】
駆動手段111では決定されたギア位置になるように自動変速機のクラッ
駆動油圧が決定されクラッチを駆動する。

【0022】
は、本発明において用いられるエンジン駆動系とその制御ユニットの構成
ている。エンジン201及びトランスミッション202からはそれぞれの
態を示す信号がATコントロールユニット203に出力される。また車両
07及びASCDコントロール（定速走行制御）ユニット信号208もA
トロールユニット203に入力される。ATコントロールユニット203
れらの信号からギア位置を決定しトランスミッション202に変速指令信
6を出力する。

【0023】
は図2において示された信号の詳細な説明である。信号304から信号3
でがエンジンからの信号204に対応し、信号308から310までがト
ミッションからの信号205に対応し、信号311から信号314までが
号207に対応し、信号315，316がASCDコントロールユニット
08に対応し、信号317から信号321までがATコントロールユニッ
206に対応する。これらの信号は入力信号処理ユニット302を介して
ントロールユニット301に入力され、ATコントロールユニット301
力信号処理ユニット303を介して出力される。

【0024】
推定の方法はスロットルを踏み込んだときの加速度、車速の加速対応が車
って違うことを利用して加速応答波形から車重を認識する方式である。こ
では、車重測定用のセンサを用いることによってコストをあげることがな
動変速機の変速制御を行うのに十分な精度で車重を推定することができる

【0025】
4は車重推定手段の詳細なブロック図である。加速度検知手段401から加
411が時系列化手段（加速度入力手段）405および時系列化開始信号発

段404に出力される。車速検知手段402から車速412が時系列化手段5に出力される。スロットル開度検知手段403からスロットル開度413系列化手段405および時系列化開始信号発生手段404に出力される。

【0026】

系列化開始信号発生手段404では加速度411とスロットル開度413の)の信号を見てスロットルが踏み込まれ、加速度が立ち上がった時つまり加速波形に対して時系列化を開始させるように時系列化手段405に信号を送る

【0027】

系列化手段405では時系列化開始信号416が出力された時点から、加速車速、スロットル開度を時系列化して時系列信号414をニューロ車重推定406に出力する。ニューロ車重推定手段406では加速度、車速、スロッ開度の時系列信号414を入力して車重の推定を行い推定車重415を出力。

【0028】

5は加速度、車速、スロットル開度の加速応答の時系列化について説明したある。加速度があらかじめ定められたしきい値αthを越えた時点tsoから時化を開始し、周期Δtで加速度、車速、スロットル開度をサンプリングする

【0029】

速度にしきい値を設けた理由を図6に示す。加速時に時系列化を行う目的でットル開度にしきい値を設け、スロットル開度の立ち上がりに同期してサンングを開始することにした場合、スロットル開度の踏み方に個人差があるた後加速度の立ち上がりにずれが生じてしまう。このずれを解消するために加にしきい値を設け、加速度がしきい値を越えた時点からサンプリングを開始ことにしている。

【0030】

17に時系列化開始信号発生手段の処理の手順を示す。まずスロットル開度がていることを確認する。次にスロットルが設定されたしきい値を越え、立ち

ちと、加速度がしきい値を越えた時点から時系列化を開始する。

)０３１】

]５の時系列化開始信号発生手段の処理の流れを示す。

'０３２】

０１：スロットル開度が閉じていればｓｔｅｐ７０２へ。そうでなけ

ｐ７０１へ。

０３３】

０２：スロットル開度がしきい値θ_{th}を越えたならｓｔｅｐ７０３へ

ければｓｔｅｐ７０２へ。

０３４】

０３：加速度αがしきい値α_{th}を越えたならｓｔｅｐ７０４へ。そう

ｓｔｅｐ７０３へ。

０３５】

０４：時系列化開始信号を出力する。

０３６】

重推定に用いるニューラルネットの学習方法を示した図である。車重
０１は入力層、中間層、出力層の３層からなるラメルハート型のニュ
トで構成されている。各層にはユニットがあり各層間のユニットの間
てつながっている。信号は入力層→中間層→出力層と伝わっていく。
が与えられておりユニットから出力された信号は枝の重みを乗算され
ットの入力となる。各ユニットでは入力信号の和からシグモイド関数
換が行われ出力される。

０３７】

ルネットの車重学習は加速度、車速、スロットル開度が入力されたと
重と実車重との誤差が小さくなるように各枝の重みを変更することに
れる。いろいろなスロットル開度の踏み込み方に対応するために、あ
つの車に対して車重、スロットル開度を変えて加速応答波形を図４に
化方法によって実験によって測定しておき、ニューラルネットに加速
スロットル開度の時系列波形を入力して推定車重９１１を出力させる

て実車重９１２との誤差９１３を求める。

【００３８】

ぇ更手段９０２では推定車重９１１と実車重９１２との誤差９１３を基に
)枝の重みを誤差が小さくなるように変更する。重みの変更アルゴリズム
ァプロパゲーションアルゴリズムが代表的であるが他のアルゴリズムを用
とい。

【００３９】

負荷を推定し、それに応じて変速制御を行うための方法は、出力トルクを
推定出力トルクと加速度、推定車重から運動方程式を解いて走行負荷を
ことにした。

【００４０】

トルクの推定方法はトルコンの滑りと回転数からトルコン特性に従って出
クを推定する方法とエンジンの回転数とスロットル開度からエンジントル
に従って推定トルクを求める方法がある。

【００４１】

ｨコンの滑りから出力トルクを推定する方法はトルコンの滑りが大きい、す
ｨ入力と出力の回転比が小さいときには精度よく推定することができるが、
ﾞ小さいところ、すなわち入力と出力の回転比が大きいところでは精度が悪
)。

【００４２】

ラエンジンの特性から出力トルクを推定する方法は運転の全領域で精度は一
が、補機類やエアコンの稼働に必要なトルクがわからないという問題がある
こでトルコンの滑りの大きい領域ではトルコンから出力トルクを推定し、同
補機やエアコンの稼働に必要なトルクも推定し、トルコンの滑りの小さい領
はエンジンからの推定トルクに先に求めておいた補機類のトルクを引いて出
ルクとすることにした。

【００４３】

１０は出力トルクの推定方法および負荷の推定方法を表した図である。エン
の発生トルクから出力トルクを推定するにはスロットル開度１０１１とエン

０１２からエンジントルクマップエンジン発生トルク推定手段）１
てエンジン出力トルク１０１５を求める。エンジン出力トルク１０
等の負荷トルク１０１６を引いたものにトルコンのトルク比１０１
ンジン回転数から求めたタービントルク１０１４を求める。

４４】

ンのポンプ回転数（エンジン回転数）１０１２とタービン回転数１
カトルクを求めるにはタービン回転数１０１３とエンジン回転数１
ービン回転数とエンジン回転数の比Ｎｔ／Ｎeを求め、トルコントル
１００２からトルコンのトルク比１０１７とポンプトルク容量係数
求める。トルコンのポンプトルク容量係数τ１０１８にエンジン回
の２乗をかけポンプトルクを求める。さらにこれにトルク比１０１
ービントルク１０１９を求める。

４５】

推定手段１００３ではエンジンからの推定タービントルク１０１４
らの推定タービントルク１０１９を比較し、タービン回転数とエン
比Ｎｔ／Ｎeが０．８より小さいときはエンジンからのタービン出力
４とトルコンからのタービン出力トルク１０１９との誤差がなくな
補機トルク１０１６を出力する。タービン回転数とエンジン回転数
eが０．８より大きいときは最新の推定補機トルクTacc１０１６を

４６】

ルク推定手段１００４ではトルコンのタービン回転数とエンジン回
／Ｎe１０２１が０．８より小さい時はトルコンからタービントルク
として出力し、０．８より大きいときはエンジンからのタービント
ービントルクとして出力する。このようにして求めた推定タービン
２にギア比ｒ１０２４をかけて推定出力トルクTo１０２３を求め
負荷トルクTL１０２８はこの推定出力トルク１０２３から推定車
有効径と加速度１０２６をかけたものを引いて求める。

【００４７】

図１１はエンジントルクマップを(a)に、トルコン特性マップを(b)に表したものである。エンジントルクマップはエンジンの回転数を横軸にとり、スロットル開度をパラメ-タとして、発生トルクを表している。トルコン特性マップは横軸にトルコンの入力と出力の回転比をとりポンプトルク容量係数τとトルコンの入力と出力のトルク比tを表している。

【００４８】

図１２は補機トルク推定手段１００３の処理の流れを表したものである。以下に処理の流れを示す。

【００４９】

ＳＴＥＰ１２０１：補機トルクＴａｃｃ＝０とする。

【００５０】

ＳＴＥＰ１２０２：トルコンのすべりｅが０．８より小さいときはＳＴＥＰ１２０３へ。そうでないときはＳＴＥＰ１２０２へ。

【００５１】

ＳＴＥＰ１２０３：エンジンからの推定タービントルクＴt1とトルコンからの推定タービントルクＴt2の差を求める。Ｔerr＝Ｔt1－Ｔt2

ＳＴＥＰ１２０４：補機推定トルクを求める。Ｔacc＝Ｔacc＋Ｔerr／ｔ

但しｔはトルコントルク比

図１３はエンジンからの推定タービントルクを求める処理の流れである。以下にその処理を示す。

【００５２】

ＳＴＥＰ１３０１：エンジン回転数Ｎeとスロットル開度ＴＶＯの値を読み込む。

【００５３】

ＳＴＥＰ１３０２：エンジン回転数Ｎeとスロットル開度ＴＶＯからエンジントルクマップに従ってエンジントルクＴeを求める。

【００５４】

ＳＴＥＰ１３０３：エンジントルクＴeから補機トルクＴaccを引いてトルコンの

トルク比ｔをかけてエンジンからのタービントルクＴt1を求める。

【００５５】

図１４はトルコンの回転からタービントルクを求める処理の流れである。以下にその処理を示す。

【００５６】

ＳＴＥＰ１４０１：車速Ｖsp、エンジン回転数Ｎe、ギア比ｒの値を読み込む。

【００５７】

ＳＴＥＰ１４０３：タービン回転数を車速とタイヤの有効径ｒwから計算する。

【００５８】

ＳＴＥＰ１４０５：トルコンの滑りｅを求めトルコン特性マップからポンプトルク容量係数τとトルコンのトルク比ｔを求める。

【００５９】

ＳＴＥＰ１４０６：エンジン回転数Ｎeを２乗したものにポンプトルク容量係数τをかけて、ポンプトルクＴpを求め、さらにポンプトルクＴpにトルコンのトルク比ｔをかけてトルコンからのタービントルクＴt２１０１９を求める。

【００６０】

なおこの処理は車速からタービン回転数を求めるかわりに直接タービン回転数を求めてもよい。この場合ＳＴＥＰ１４０１，ＳＴＥＰ１４０３は以下の処理で置き換えられる。

【００６１】

ＳＴＥＰ１４０２：エンジン回転数Ｎeの値を読み込む。

【００６２】

ＳＴＥＰ１４０４：タービン回転数Ｎｔの値を読み込む。

【００６３】

図１５は推定出力トルクと加速度から推定負荷トルクＴLを求める処理の流れである。以下に処理を示す。

【００６４】

ＳＴＥＰ１５０１：トルコンの回転比ｅが０．８より小さいならばＳＴＥＰ１５０２へ、そうでなければＳＴＥＰ１５０３へ。

【0065】

STEP1502：推定タービントルクTtをトルコンからのタービントルクTt$_2$とする。STEP1504へ。

【0066】

STEP1503：推定タービントルクTtをエンジンからのタービントルクTt$_1$とする。

【0067】

STEP1504：推定タービントルクTtにギア比rをかけて推定出力トルクT_oを求める。

【0068】

STEP1505：推定出力トルクToから推定車重Mに有効タイヤ径rwと加速度αをかけたものを引いて推定負荷トルクTLを求める。

【0069】

図16は補機類のトルクを求める別の方法を示している。この方法は補機類のトルクをあらかじめ機器ごとに設定しておきその機器がONになっているときにはその値を加えるというものである。この図ではエアコンのトルクを例にとっている。

【0070】

STEP1601：Tacc＝0

STEP1602：エアコンがONになっていればSTEP1603へ、そうでなければ終りへ。

【0071】

STEP1630：Tacc＝Tacc＋Tac

次に推定負荷及び推定車重をもとに変速パターンを変える制御について説明する。図17は推定車重および推定負荷からギア位置を決定するギア位置決定手段のブロック図である。

【0072】

シフトアップ変速線選択部1701は車重信号1711および負荷信号1712を入力とし、シフトアップ変速線1714をギア位置最終決定手段1703に

出力する。シフトダウン変速線選択部１７０２は負荷信号１７１２を入力としてシフトダウン変速線１７１５を出力する。ギア位置最終決定手段１７０３は車速信号１７１６とスロットル開度信号１７１７とシフトアップ変速線１７１４とシフトダウン変速線１７１５を入力として変速信号１７１３を出力する。

【００７３】

図１８はシフトアップとシフトダウンの車重と負荷による制御について示したものである。シフトアップの場合には図１８(a)のような変速マップを用い、シフトダウンの場合には(b)のような変速マップを用いる。

【００７４】

シフトアップの場合には車重、負荷が大きくなるにつれ変速線は１，２，３と移動する。またシフトダウンの場合には負荷が大きくなるにつれＡ，Ｂ，Ｃと変速線が移動する。

【００７５】

シフトダウンの場合に変速線Ａがスロットル開度が小さい場合に車速が高いほうに変速線が移動しているのはエンジンブレーキを意図している。

【００７６】

本実施例によれば自動車の運転特性から車重を推定し、出力トルクについてはトルコンのすべりまたはエンジンの回転数とスロットル開度から推定して、出力トルクと加速度から走行負荷を推定し、シフトアップ時には車重および走行負荷の両方を利用して変速線を移動し、シフトダウン時には走行負荷のみを考慮して変速線を移動することにより、燃費が向上し、運転状況に応じた的確な変速が可能となる。

【００７７】

なお、本実施例は、車重を推定することとしてが、本発明は、これに限られるものではなく、車重をセンサにより、直接計測することとしても良い。

【００７８】

【発明の効果】

本発明によれば、走行負荷を推定し、車重及び走行負荷にあわせた変速を実行する自動車の自動変速制御装置を提供することができる。

【００７９】

る。

【図面の簡単な説明】

【図１】

本発明に係る自動変速制御装置を含む変速制御系のブロック図。

【図２】

本発明に係る自動変速制御装置を含む変速制御系のハードウェアのブロック図

。

【図３】

ＡＴコントロールユニットへの入力信号と出力信号の詳細を示す説明図。

【図４】

車重推定手段を含む車重推定系の構成図。

【図５】

加速応答波形の時系列化について示した説明図。

【図６】

時系列化を開始するための方法について示した説明図。

【図７】

時系列化開始信号発生の処理の流れを示した説明図。

【図８】

時系列化開始信号発生手段の処理の流れについて示したフローチャート。

【図９】

車重推定手段に使うニューラルネットの学習方法について示した説明図。

【図１０】

トルクコンバータ発生トルク推定手段とエンジン発生トルク推定手段と負荷推定手段を含む変速制御系のブロック図。

【図１１】

エンジンのトルクマップとトルコン特性マップの説明図。

【図１２】

補機トルクの推定処理の流れを示したフローチャート。

【図１３】

エンジン発生トルク推定の処理の流れを示したフローチャート。

【図１４】

トルコンから出力トルクを推定する処理の流れを示すフローチャート。

【図１５】

推定出力トルクから走行負荷トルクを推定する処理の流れを示すフローチャート。

【図１６】

補機トルクの推定の別の方法の処理の流れを示すフローチャート。

【図１７】

ギア位置決定手段の構成図。

【図１８】

負荷推定及び車重推定による変速スケジュールの変更方法の変速マップを示した説明図。

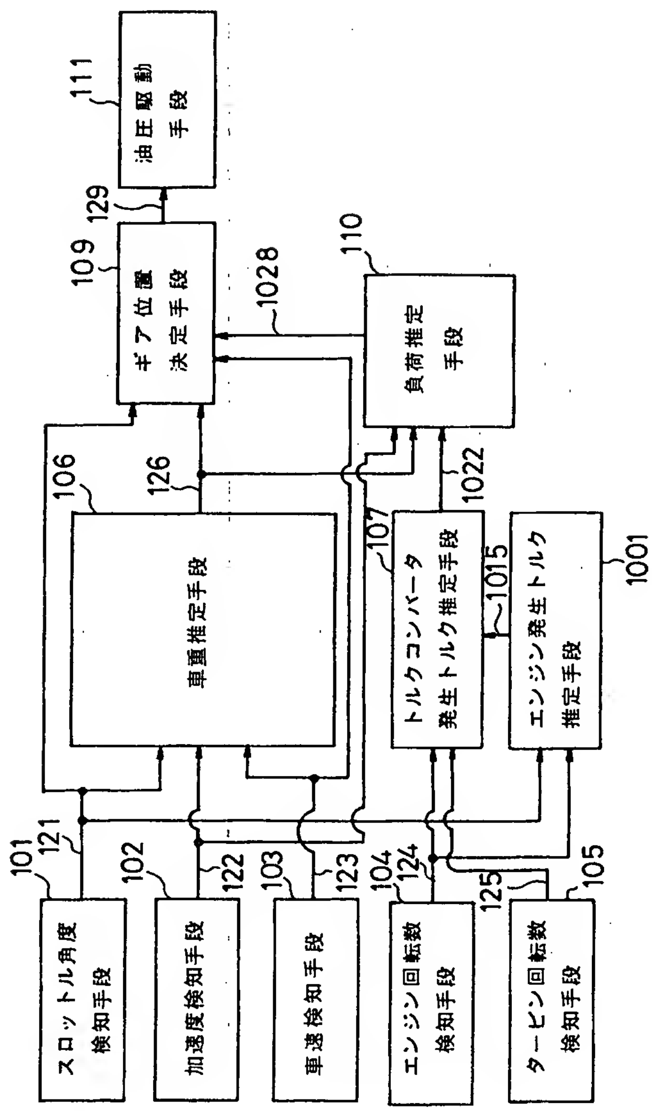
【符号の説明】

１０１　　スロットル開度検知手段
１０２　　加速度検知手段
１０３　　車速検知手段
１０４　　エンジン回転数検知手段
１０５　　タービン回転数検知手段
１０６　　車重推定手段
１０７　　トルクコンバータ発生トルク推定手段
１０８　　エンジン発生トルク推定手段
１０９　　ギア位置決定手段
１１０　　負荷推定手段
１１１　　油圧駆動手段

【書類名】　図面

【図１】

図1



111
油圧駆動手段
129
109
ギア位置決定手段
1028
110
負荷推定手段
106
126
車重推定手段
1022
107
トルクコンバータ発生トルク推定手段
1015
1001
エンジン発生トルク推定手段
101
121
スロットル角度検知手段
102
122
加速度検知手段
103
123
車速検知手段
104
124
エンジン回転数検知手段
125
105
タービン回転数検知手段

図 2

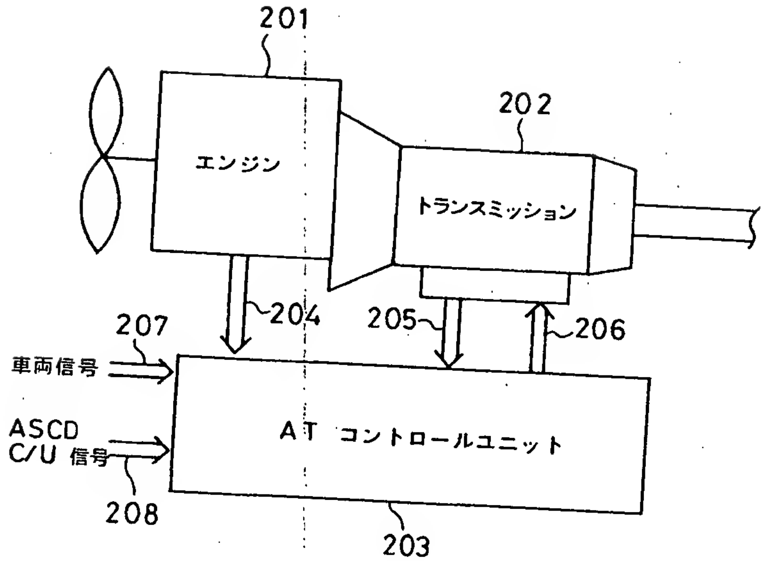

201
エンジン
202
トランスミッション
204
205
206
207
車両信号
ASCD
C/U 信号
208
AT コントロールユニット
203

図3

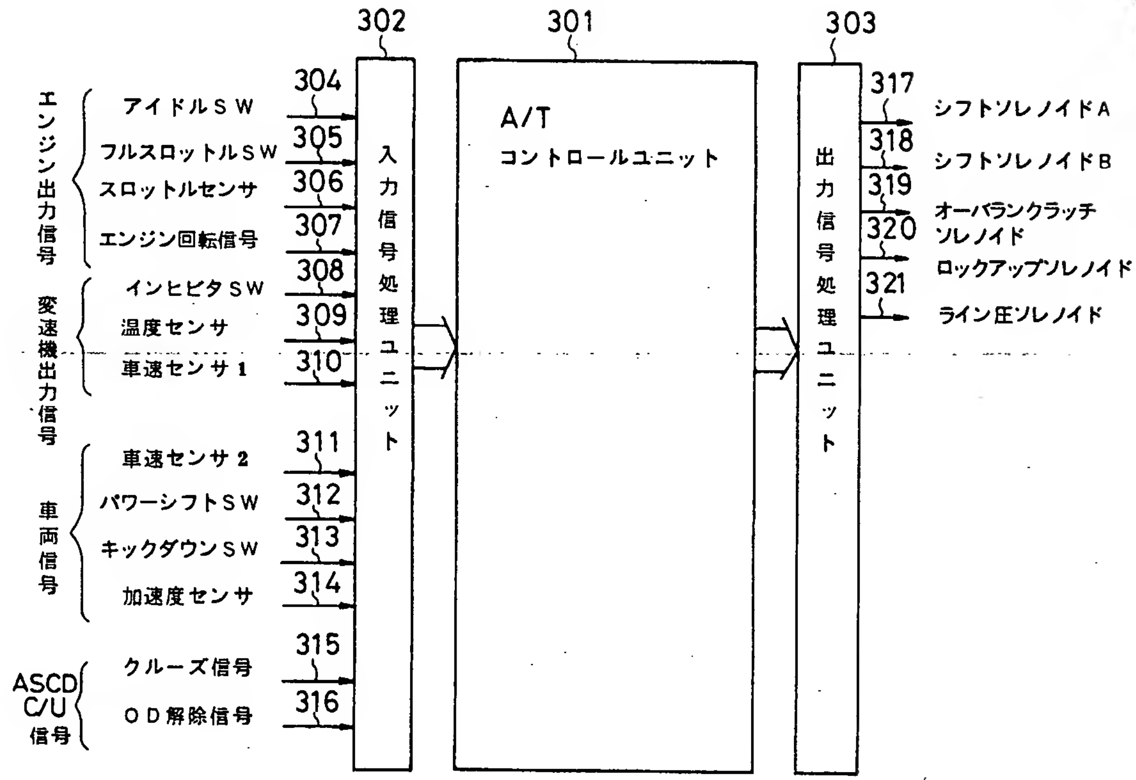
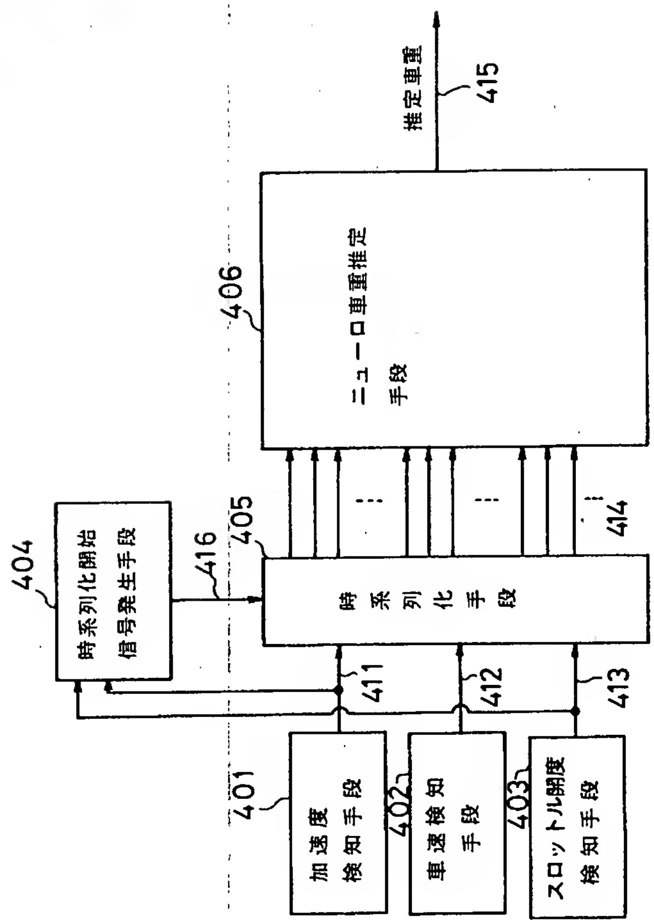

302
301
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
エンジン出力信号
アイドルSW
フルスロットルSW
スロットルセンサ
エンジン回転信号
変速機出力信号
インヒビタSW
温度センサ
車速センサ1
車両信号
車速センサ2
パワーシフトSW
キックダウンSW
加速度センサ
ASCD C/U 信号
クルーズ信号
OD解除信号
入力信号処理ユニット
A/T
コントロールユニット
出力信号処理ユニット
シフトソレノイドA
シフトソレノイドB
オーバランクラッチソレノイド
ロックアップソレノイド
ライン圧ソレノイド

図 4


401
加速度検知手段
402
車速検知手段
403
スロットル開度検知手段
404
時系列化開始信号発生手段
405
時系列化手段
406
ニューロ車重推定手段
411
412
413
414
415
416
推定車重

【図5】

図 5

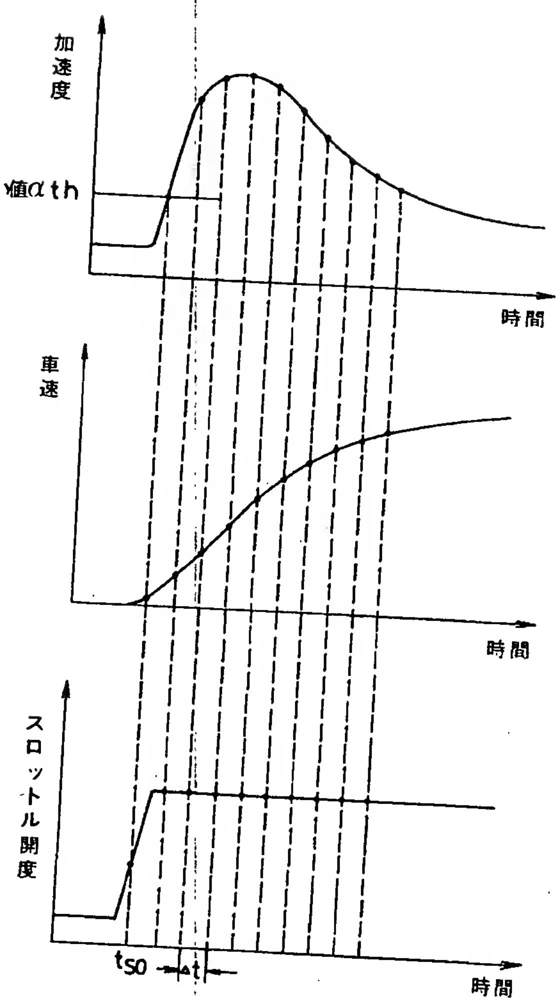


図6

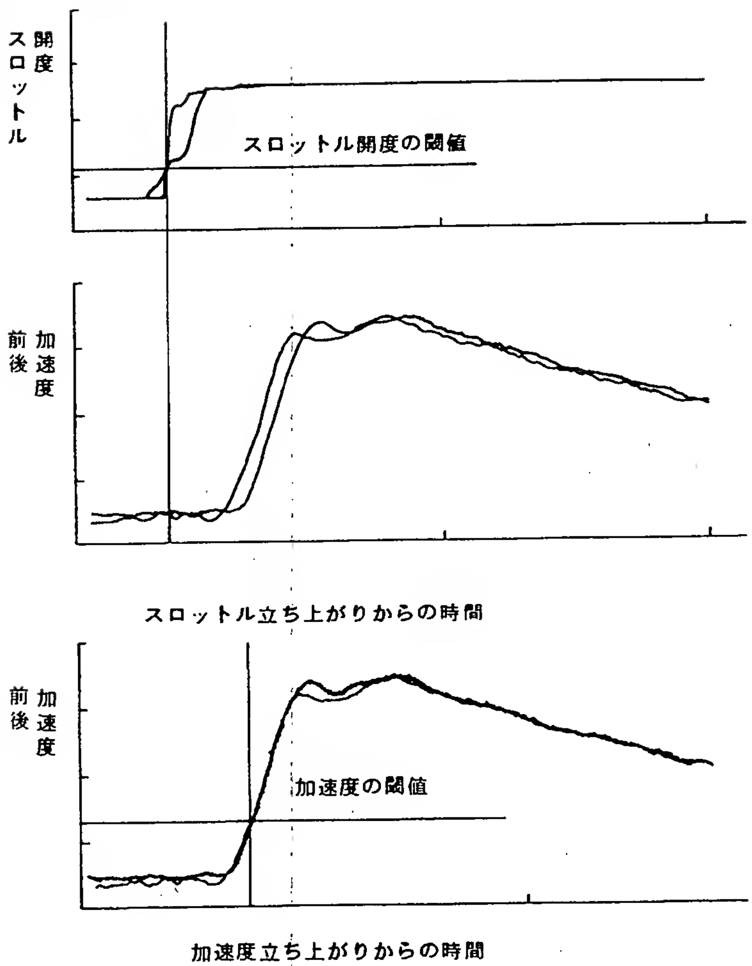

スロットル開度
スロットル開度の閾値
前後加速度
スロットル立ち上がりからの時間
前後加速度
加速度の閾値
加速度立ち上がりからの時間

図7

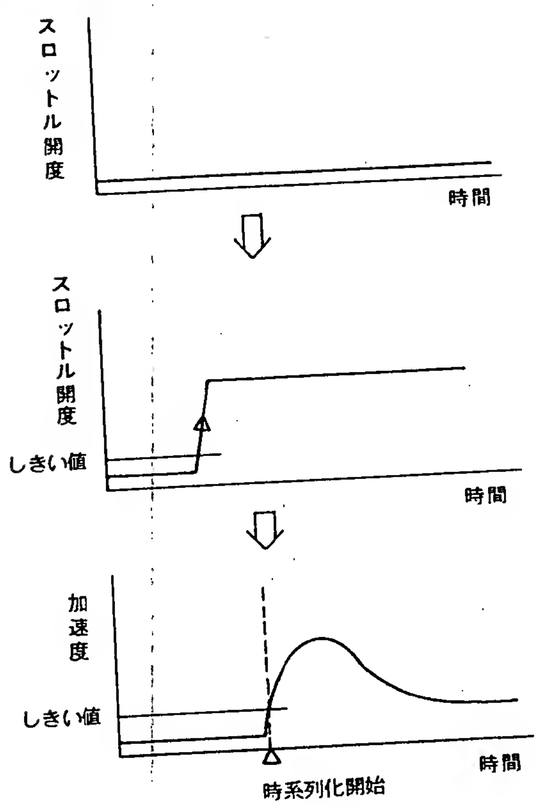


図 8

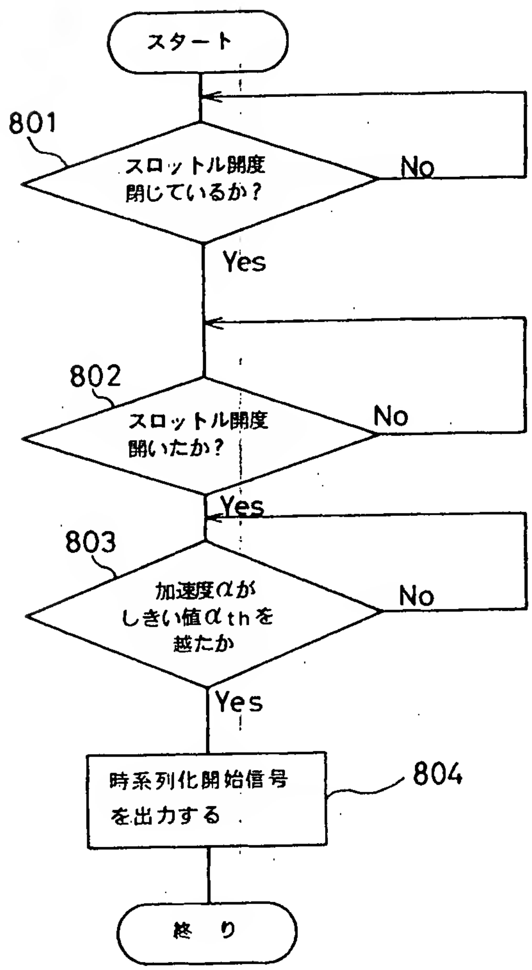

スタート
801
スロットル開度
閉じているか？
No
Yes
802
スロットル開度
開いたか？
No
Yes
803
加速度αが
しきい値αthを
越たか
No
Yes
時系列化開始信号
を出力する
804
終 り

図 10

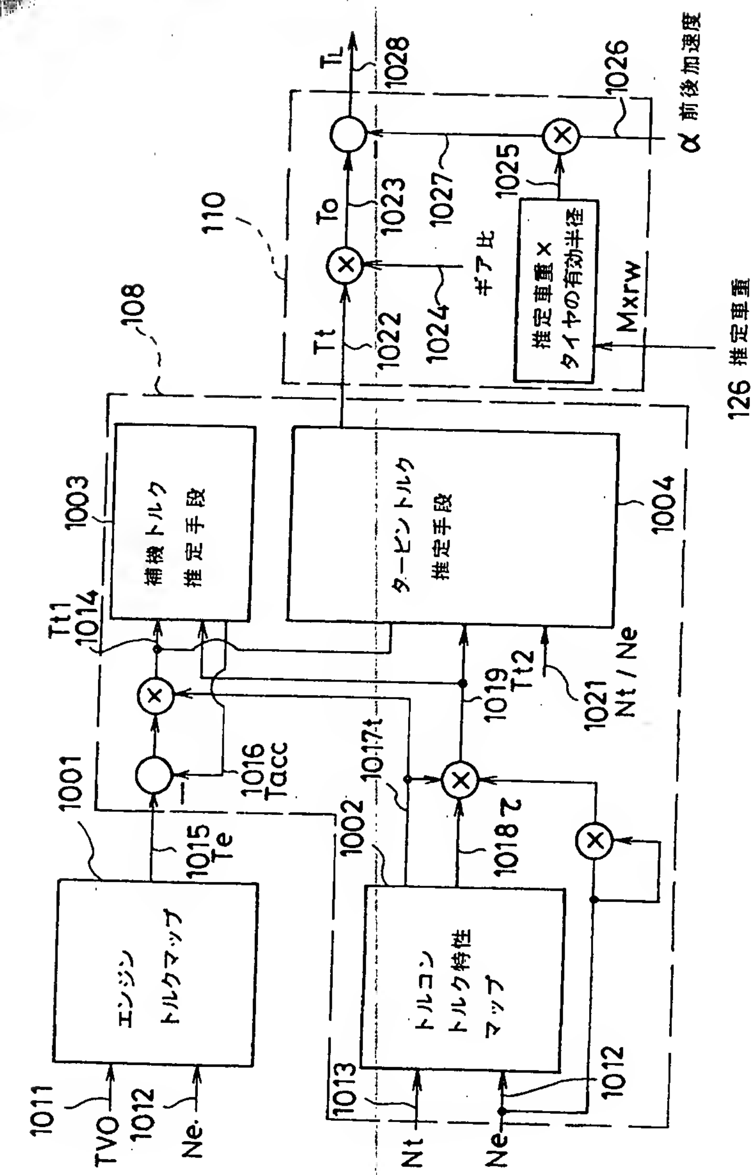
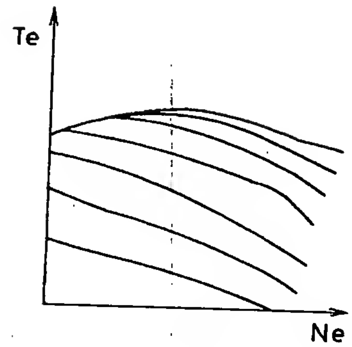
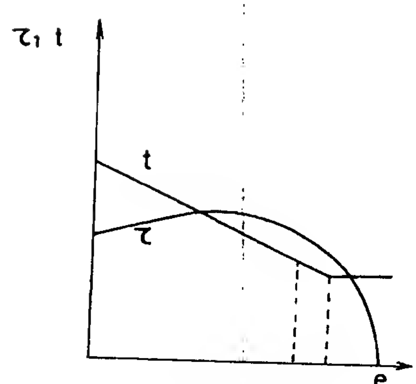

エンジン トルクマップ
トルコン トルク特性 マップ
補機トルク 推定手段
タービントルク 推定手段
推定車重× タイヤの有効半径
TVO
Ne
Nt
Te
Tacc
τ
Tt1
Tt2
Nt / Ne
Tt
To
TL
ギア比
Mxrw
126 推定車重
α 前後加速度
1001
1002
1003
1004
1011
1012
1013
1014
1015
1016
1017
1018
1019
1021
1022
1023
1024
1025
1026
1027
1028
108
110

図11



エンジントルクマップ



トルコン特性マップ

12】

図 12

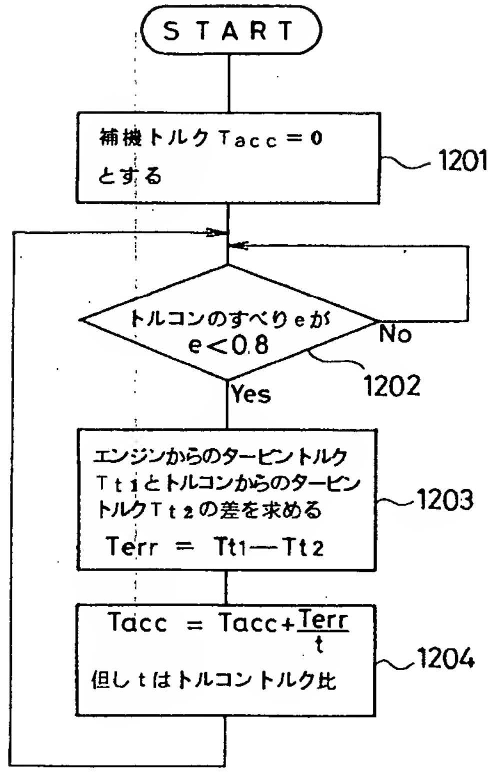

START
補機トルク Tacc＝0
とする
1201
トルコンのすべり e が
e＜0.8
No
Yes
1202
エンジンからのタービントルク
Tt1とトルコンからのタービン
トルクTt2の差を求める
Terr ＝ Tt1－Tt2
1203
Tacc ＝ Tacc＋Terr/t
但し t はトルコントルク比
1204

図 13

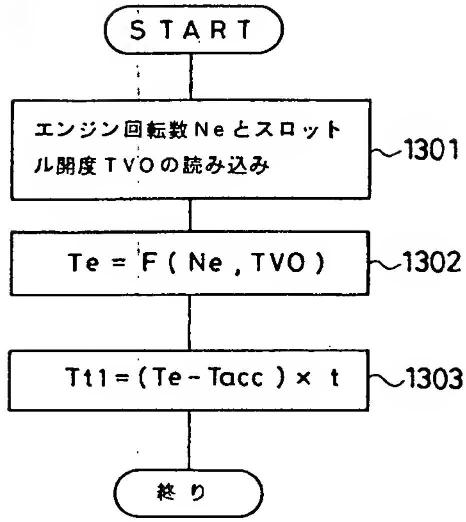

START
エンジン回転数Neとスロットル開度TVOの読み込み
1301
Te = F (Ne , TVO)
1302
Tt1 = (Te − Tacc) × t
1303
終り

図 14

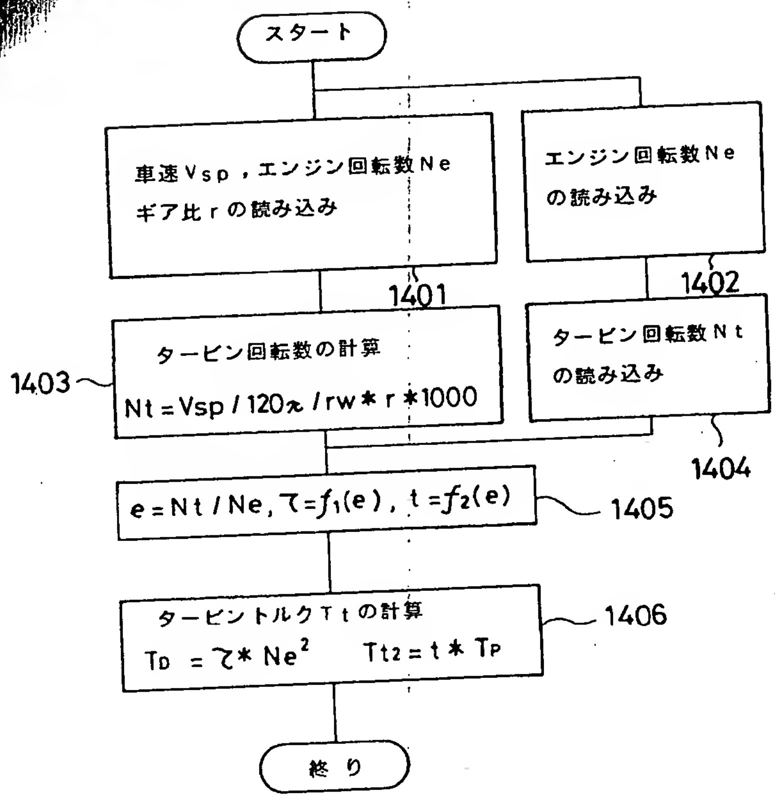
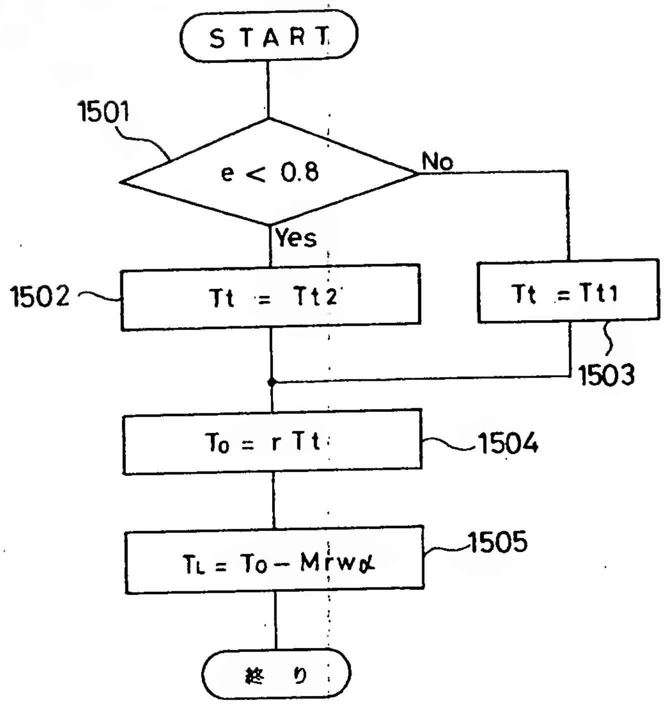
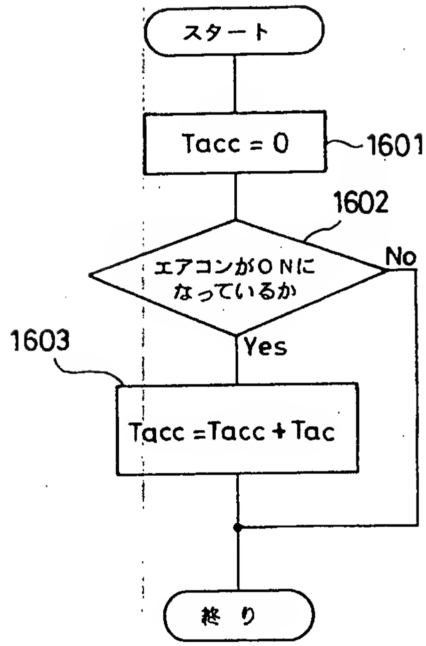

スタート
車速Vsp，エンジン回転数Ne
ギア比rの読み込み
1401
エンジン回転数Ne
の読み込み
1402
1403
タービン回転数の計算
Nt＝Vsp／120π／rw＊r＊1000
タービン回転数Nt
の読み込み
1404
e＝Nt／Ne，τ＝f1(e)，t＝f2(e)
1405
タービントルクTtの計算
TD ＝τ＊Ne2　Tt2＝t＊TP
1406
終り

図 15


START
1501
e < 0.8
No
Yes
1502
Tt = Tt2
Tt = Tt1
1503
To = r Tt
1504
TL = To − Mrwα
1505
終 り

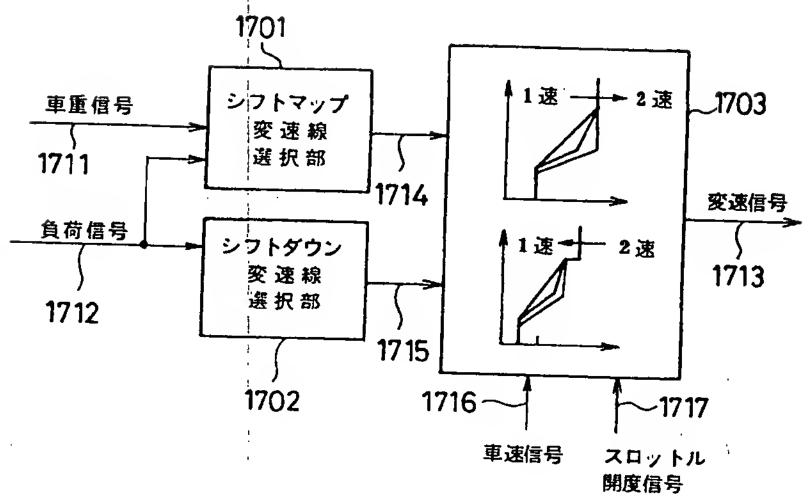
【図16】

図 16


スタート
Tacc = 0
1601
1602
エアコンがＯＮになっているか
No
Yes
1603
Tacc =Tacc + Tac
終り

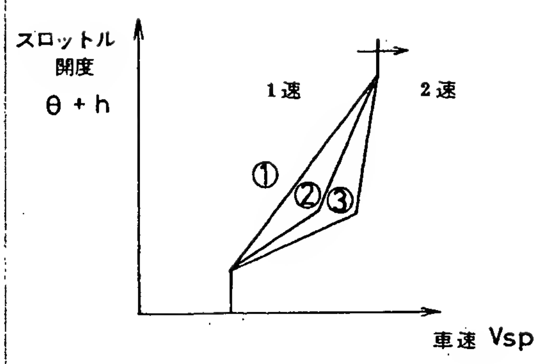
【図17】

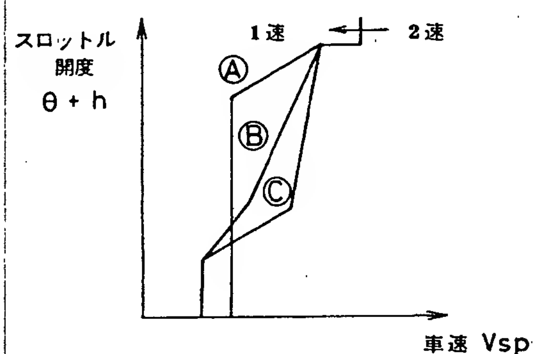
図 17


1701
車重信号
シフトマップ
変速線
選択部
1711
負荷信号
シフトダウン
変速線
選択部
1712
1702
1714
1715
1 速
2 速
1703
変速信号
1713
1716
1717
車速信号
スロットル
開度信号

18】

図 18





【書類名】　要約書

【要約】

【目的】　本発明の目的は、車重と走行負荷を推定し車重及び走行負荷にあわせた的確な変速を実行し、燃費向上を図ることである。

【構成】　自動車の車重の推定を行なう車重推定手段と、出力トルクの推定を行なうトルク推定手段と、加速度信号を受付ける加速度入力手段と、得られた車重、出力トルク、加速度から走行負荷を推定する負荷推定手段と、複数の変速スケジュールの記憶手段と、得られた車重と走行負荷に応じて上記変速スケジュールから一つを選択し、選択された変速スケジュールに従ってギア位置の決定を行なうギア位置決定手段とを有する。

【選択図】　図1

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Attachment 1.c

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Attachment 2

No. 1500

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CERTIFICATION

This is to certify that the following is, to the best of our knowledge and belief, a true and accurate translation into English of the attached Japanese language document (03-319205)

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STATE OF CALIFORNIA)
COUNTY OF LOS ANGELES) ss

Sworn and subscribed to before me this 18th day of February 1993.

Mary Rees

NOTARY PUBLIC

OFFICIAL NOTARY SEAL
MARY REES
Notary Public — California
LOS ANGELES COUNTY
My Comm. Expires APR 15, 1995

03-319205

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